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Executive summary

This study has been taken up at the instance of the Reliance Industries Limited to estimate the demand for natural gas in seven selected states in western and northern India. The demand estimates, upto 2011/12, have been developed in connection with the proposed import of LNG by Reliance Industries at Jamnagar, Gujarat from the liquefaction plant being set up in Iran by NIOC with Reliance and BP.

Overview of the Indian gas industry

- India produces around 75 MMCMD (18.75 million tonnes per year of LNG) of natural gas. The western offshore fields near Mumbai produce 75% of the gas. A part of the gas from the western offshore fields is consumed around Mumbai. Most of it is taken to Gujarat and fed into the 2000 km. long HBJ pipeline.
- The HBJ pipeline with a capacity of 33.4 MMCMD (8.2 mt) runs through the states of Gujarat, Madhya Pradesh, Rajasthan, Uttar Pradesh and Delhi to end in Haryana. The pipeline supplies gas to fertilizer units, power plants, two refineries and industrial units.
- 90% of the gas in India is produced by two national oil companies, ONGC and OIL. The balance is produced in two medium sized fields - the Panna-Mukta-Tapti fields in the western offshore basin operated by Enron and the Ravva field off the coast of Andhra Pradesh operated by Cairns Energy. Besides these, a number of small fields are operated in the private sector but the production from these fields is negligible.
- The recoverable gas reserves in the country stand at 650 BCM (billion cubic metres). The gas production has reached a peak and is projected to decline in the coming years. The government has accordingly invited private sector participation in exploration for oil and gas and has also explored the feasibility of importing gas.
- The new exploration licensing policy (NELP) launched in 1999 offers attractive terms to investors and also provides a level playing field with the NOCs. The first round of bidding resulted in the award of 25 exploration blocks. An investment of $ 250 million in these blocks has been indicated

and expectations of new finds are high. Cairns Energy has already announced the discovery of gas fields off Gujarat and Andhra Pradesh. The contracts for 23 blocks under the second round of bids have been signed recently.

- Import of gas through pipelines has been pursued from Oman, Iran, Bangladesh, Myanmar, etc. None of these projects have made much progress. In the recent years, the emphasis has shifted to the import of LNG. A number of proposals to import LNG have received clearance from the government. The work of construction has reached an advanced stage at Dabhol, Maharashtra and has started at Dahej, Gujarat.
- The Gas Authority of India Ltd. (GAIL) was formed in 1984 to build and operate the HBJ pipeline. Later, the marketing assets of ONGC were transferred to GAIL. GAIL is now the owner of all long distance gas pipelines although it does not enjoy any exclusive legal rights on gas transmission. The gas produced by Enron and Cairns is also marketed by GAIL, as the nominee of the government.
- Gas is allocated to consumers by the government. The government also fixes the gas prices. These prices are now linked to international fuel oil prices subject to a ceiling price of Rs.2850/thousand cubic metres ($1/MMBtu= Rs 1825/thousand cubic metres) and a floor of Rs. 2150/thousand cubic metres.
- The price notification of 1997 envisaged full parity with fuel oil by 2002 subject to a review by the government. While the review was in progress, the government received a proposal from GAIL for pooling of domestic gas prices and the price of imported LNG. It is not clear what the formula for pooling would be. A decision is expected in the coming months.
- Private operators of gas fields have the freedom to market gas at negotiated prices. ONGC will be allowed to do the same from blocks awarded under the NELP. The gas from imported LNG can also be marketed at negotiated prices.
- At present the gas price at any location is the same for all consumers. 80% of the gas is consumed in power generation and the production of urea. These two sectors would provide the bulk of the demand even when the gas prices are market determined.
- An independent regulatory authority is likely to be appointed for the gas industry soon. The regulator would fix pipeline tariffs but would not regulate the gas price. The regulator may also regulate access to pipelines but it is not clear if third party access would be allowed into GAIL's pipelines.

- Gujarat has enacted legislation making it mandatory to seek government approval for gas transportation in the state. Access to pipelines in the state would be open. Other states are contemplating similar laws.
- The Gujarat Act is yet to be brought into force as the central government is examining its legal validity. The matter is under discussion between the two governments.
- A policy on LNG has been in the offing for sometime. It is expected that the LNG policy would provide for a light handed regulation of the industry.
- The LNG shipping policy seeking to maximise Indian participation in LNG shipping was announced last year. Import of LNG was allowed only on fob basis. The LNG transporters had to have 26% equity holding by an Indian shipping company throughout the period of contract. The Indian company had to be associated with operating the ships so that there was an effective transfer of know how in manning and operation of these vessels to Indian personnel. Tax concessions were proposed to facilitate the conversion of vessels to the Indian flag. The policy also sought to encourage shipyards in India to get into repairing of LNG carriers.
- This policy is now under review. The stipulation of fob imports is proposed to be replaced by the requirement that only Indian vessels would be allowed to carry LNG into the country.
- If this more restrictive condition is imposed, the shipping cost would increase on account of the higher corporate tax rate in India. A policy announcement is expected in the coming months.

Demand projections

- The states selected for the study are Gujarat, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana, Delhi and Rajasthan. These states are located in the western and the northern parts of the country. They account for two-thirds of the gas used in the country at present. The gas demand is estimated for these states for 2006/7 and 2011/12.
- The bulk of the gas demand is expected from the power and the fertiliser sectors. Both these sectors are going through policy reforms that would seriously affect their growth. The gas demand has accordingly been estimated under two different scenarios - high reforms and low reforms.
- In the high reforms scenario we assume that
  - power tariffs are revised annually by the regulators
  - the orders of the regulators are implemented by the government
  - T&D losses are reduced

  - utilities start making profits
  - power shortage is wiped out by 2011/12
  - the price of urea is decontrolled by 2006.
- In the low reforms scenario, the tariff reforms would be slower, the utilities would continue to depend on government subsidies. The improvement in T&D losses would be slower. Only half the current power shortage is removed by 2011/12. The decontrol of urea prices would be deferred to 2010.
- The demand potential is investigated separately for the following sectors:
  - Existing consumers
  - Power
  - Urea production
  - Industry
  - Captive generation
  - City distribution
- The imputed values of gas use in these sectors and the creditworthiness of customers are discussed along with the demand.

Existing consumers

Demand

- The consumers along the HBJ and other consumers in Gujarat not connected to the HBJ but supplied gas through local grids, have a total demand of 59.02 MMCMD (14.76 mt). The current supply of 43.13 MMCMD (10.78 mt) fall short of the demand. The fields in the western offshore and in Gujarat have entered a declining phase and the gas supply to these consumers is projected to go down. In 2006/7 the supply will be 51.64 MMCMD (12.91 mt) leaving a deficit of 7.38 MMCMD (1.85 mt). The deficit in 2011/12 is projected to be 18.06 MMCMD (4.52 mt). This is shown in the Table below.

Table 1 Deficit for existing consumers (million tonnes)

Demand / supply		2001/2	2006/7	2011/12
Demand		14.76	14.76	14.76
Supply	Gujarat-ONGC	1.52	0.73	0.17
	Gujarat-non-ONGC	0.08	1.25[a]	2.00[b]
	Western-offshore	9.19	10.93[c]	8.07[d]
	Total	10.78	12.91	10.24
Deficit		3.98	1.85	4.52

[a] Includes 0.75 mt from Hazira field of GSPCL and 0.50 mt from offshore field of Cairns Energy. The production is scheduled to reach 1.0 mt by 2003 and 1.25 mt by 2004;

[b] Includes 1.0 mt each from GSPCL and Cairns. Output from Cairns could go up to 2.0 mt;

[c] Includes a production of 0.37 mt from anticipated reserves.

[d] Includes a production of 1.25 mt from anticipated reserves

- These projected deficits would have to be met by imported gas. In a shortage situation, the supply to units is kept proportionate to the allocation. The deficit is expected to be shared by the consumers accordingly.

Power

Demand

- The 16th Electric Power Survey published this year by the Central Electricity Authority, Government of India forms the starting point for the projection of power demand. This survey has projected statewise and sectorwise power demand upto 2016. These projections are based on detailed discussions with the state governments and the utilities.
- We have revised the 16th EPS projections downward for Uttar Pradesh, Punjab and Haryana as these were considered too high. The projected growth rate for these states is much higher than the rates observed in the nineties. The mismatch between the earlier EPS projections and actuals were also high in these states. We have assumed that the growth rate in energy demand in these states would equal the rates achieved in the nineties. The projections for the other states have been accepted.
- All the states have been suffering shortages in energy and peak demand. In the high reforms scenario, it has been assumed that the energy shortages will disappear by 2011/12. However they will continue till 2006/7 (except in Gujarat) as any improvement by that date is unlikely.
- T&D losses exceed 20% in these states. The regulators appointed in Gujarat, MP, UP, Haryana, Delhi and Rajasthan have laid down targets for an improvement in the situation. The targets may not be met but some improvement is expected. In the high reforms scenario, we assume that the T&D losses improve in all these seven states by 2% by 2006/7 (relative to EPS projections) and a further 3% by 2011/12.
- These states have seen a high growth in captive generation. This has resulted from the inadequacy of supplies and the high prices paid by industrial consumers. The EPS projects a sharp reduction in captive generation in some states and moderate changes in the others. We have accepted these projections in the high reforms case.

- The installed capacity in the states adds up to 39562 MW. The average PLF is 58%. A scrutiny of projects under consideration indicates that 3603 MW of capacity addition is likely by 2006/7 and a further 13555 MW is likely by 2011/12. The capacity addition is inadequate compared to the demand growth. All power generators would be under pressure to improve their performance. We assume that the PLF of all existing and new units will improve by 5%. This was the experience in the nineties.
- In the low reforms scenario, the existing shortages remain till 2006/7 as before but only half the shortages are removed by 2011/12. Improvement in T&D losses is slower with no improvement till 2006/7 and only a 2% improvement by 2011/12. The rationalisation of power prices is also slower and therefore growth in captive generation is higher. The improvement in the PLF is assumed to be the same as in the high reforms case. The capacity addition is the same till 2006/7 but the Hirma super thermal project assumed to come on stream by 2011/12 does not come through in this case.
- In both the scenarios, capacity addition is needed beyond what is considered likely. This extra capacity is counted towards the gas demand. For 2006/7, only gas based units are possible if this extra capacity is to be put in place. For 2011/12, there is enough time to put up coal fired or even hydel units but gas would be the preferred fuel if the supply can be tied up early at competitive prices.
- In the high reforms case, this extra capacity could be set up in all states. In the low reforms case this will be an added burden on the state governments and we assume that these will come through only in some states.
- In the high reforms scenario, it is assumed that all states go on the high reforms path. Likewise in the low reforms scenario. These assumptions produce the upper and the lower bounds of the demand. Intermediate figures can be generated using different permutations.
- In planning generation capacity, the additional capacity requirement is usually calculated with reference to the peak load and an assumed loss of load probability of 1%. We consider this impractical for these states. The method outlined above is much more conservative.

Imputed values

- The relevant alternative fuels are domestic and imported coal. We have taken all the locations in the states where power projects are under consideration. For these locations, the delivered cost of coal has been estimated taking current prices and freights for domestic coal and two probable cif prices for imported coal. No indications of future prices and railway freights are available. This introduces some uncertainty in imputed value calculations.

- Both subcritical and supercritical coal plants have been considered.
- The low grade coal used for power generation has an ash content of around 40%. In order to combat the fly-ash problem, it was envisaged by the government that power plants more than 1500 kms from the coal mines (this covers our locations) should use washed or blended coal with an ash content of 34%. This rule was to be made effective from June 2001, but the date has been postponed by one year. We have considered the alternatives of using washed or blended coal.
- This gives us a set of values, all of which would be useful in price negotiations but for planning gas supplies, the lowest value at each location would be relevant.
- Two levels have been taken for the efficiency of the gas turbine - 56% and 52%.
- The comparison with power from coal pithead plants is complicated by the absence of data on power transmission costs. In the indicative case of Hirma, the fixed cost of generation has been assessed at Rs 1.33 (2.9 cents), the fuel cost at 41 paise (1 cent) and the transmission cost at 60 paise (1.3 cents) for our states. The total of Rs 2.34 per kwh (5.1 cents per unit) provides a benchmark. The generation cost of hydel would be near Rs 3 per kwh (6.5 cents per unit) but the transmission cost would be lower.
- All power produced has to be sold to the utilities through Power Purchase Agreements (PPA). The tariff payable to NTPC is regulated by the CERC but the tariffs for IPPs are not directly regulated. In all cases, the fuel cost is allowed as a pass through so that the power producer has no incentive to reduce the fuel cost. However, the PPAs are subject to regulatory approval and fuel cost is allowed only if it competes with other fuels.

Creditworthiness

- The main player in the power sector is the NTPC, a central government undertaking with over 21,000 MW of installed capacity including seven gas based units. NTPC is one of the 'Navaratna' companies, which have been granted a large measure of autonomy by the government. The concerns arise out of outstanding dues of over Rs 10,000 crores ($ 2.2 bn) receivable from SEBs and the fixing of tight norms by the CERC in determining tariffs payable to NTPC. NTPC enjoys the full support of the central government.

- The IPPs active in this area include Gujarat Torrent, Essar, RP Goenka, Reliance, etc. Out of these only Essar is in financial trouble right now.
- These are all first rate companies and no bank should have any problem dealing with them. However, the system under which they operate is equally important. The State Electricity Boards are all in the red. They are dependent on grants to meet their deficits. An improvement in the situation can come about only if the tariff is rationalised. This is a process that has started off in the last two years with the installation of independent regulators but progress has been slow. Tariff orders have been passed in Gujarat, UP, Haryana, Delhi, and Rajasthan. The splitting of generation, transmission and distribution has started in UP, Delhi and Rajasthan. However, in none of the states has the new regulation made a strong impact in terms of increased collections, improvement in T&D losses or the ROR achieved by the SEBs.
- Some of the financial indicators for these SEBs are as below:

Table 2 Finance health of SEBs

States	Unit cost (cents/kwh)	Unit tariff (cents/kwh)	Loss ($ million)	RoR (%)	Subsidy /govt. receipts (%)	Reforms (Rank)
Gujarat	7	5	314	-27	16	4
Madhya Pradesh	6	4	478	-47	16	5
Uttar Pradesh	6	4	605	-15	8	3
Punjab	5	4	284	-32	-0.75	7
Haryana	6	5	178	-29	16	6
Delhi	10	7	258	-72	24	2
Rajasthan	7	4	294	-34	10	1

- The ranking of the states by the progress of reforms takes into account the number of tariff orders passed, implementation of orders by the government, decision on unbundling and privatisation.
- As things stand today, PPAs signed by these SEBs will not support a gas supply contract. Assuming that the SEBs have to show improvements for three years in a row in order to generate confidence in lenders, the earliest that could happen would be around 2005/6.
- The demand numbers worked out above are different for the high reforms and the low reforms cases. The real difference is however in the ability to pay for the gas. In the high reforms case the fuel cost would be realised from the consumer; in the low reforms case the added cost will be borne by the government.

- Discussions with NTPC indicate that they would be able to take up three expansion projects totalling to 1950 MW by 2006/7 if gas is available. With NTPC as the power producer, the demand would be bankable in spite of the financial position of the SEBs. Accordingly, this has been taken as the good quality, reliable demand from the power sector by 2006/7. For 2011/12, the entire demand in the low reforms case has been included in this category as it would be possible for NTPC to generate the required power.

ea production

Demand

- Over the long term, urea consumption in India has grown at 5% but there has been a slow down in the last two years.
- 75% of the urea is used in producing foodgrains. Changes in the cropping pattern are expected in view of the WTO agreements. A major shift towards cash crops and production for export may affect urea consumption. However, in the absence of clear indications of the extent of change, we assume a continuation of past trends.
- The urea price is controlled by the government. This requires a subsidy which is currently around Rs 14,000 crores ($3 bn) annually. The Expenditure Reforms Commission has recommended the decontrol of urea prices by 2006. There is considerable uncertainty over the feasibility of decontrol by that date.
- Price decontrol would imply a sharp rise in prices and would affect urea use. We have assumed that urea would be used more efficiently.
- Equally important changes are expected in urea production. Under a protected environment, the production capacity has built up to 20 MMTPA of urea. Under WTO agreements, imports have to be decanalised and the domestic industry protected through a tariff.
- At present, urea producers are allowed prices that meet all costs and provide a fixed return on investment. This regime has no incentive for efficiency or the use of cheaper fuels. In a competitive situation, urea producers have to compete against each other and with imports. Naphtha based units have to change over to gas in order to survive.
- The setting up of additional capacity after price decontrol would need adequate protection. Food security is an important consideration and it is likely that the government would provide the necessary protection for LNG/ gas based units to come up.

- The gas demand from this sector has been estimated keeping in view the possibility of additional capacity as well as conversion from naphtha. In the high reforms case we assume that price decontrol occurs in 2006 but in the low reforms case this gets postponed to 2010. In the high reforms case, it becomes imperative for naphtha units to change over to gas by 2006. In the low reforms case, the change over is not imperative. However, the government may persuade the naphtha units to change over to gas in order to reduce the subsidy. In both cases we assume that the demand from converted naphtha based units comes in 2006/7.

Imputed values

- If we go by the recommendations of the Expenditure Reforms Commission, the farmgate price of urea would be Rs 7000/MT. Urea producers would get a concession of Rs 1900/MT and the ex-plant price received by the producer would be Rs 8600/MT, assuming a marketing cost of Rs 300/MT. The imputed value in this case is independent of the location. It would however be different for new units and existing depreciated units. The values have been calculated for both existing and new units.
- If the competition is with imported urea, at different tariffs, the imputed values would differ between locations to reflect the cost of moving urea.
- The imputed values have also been computed with naphtha as the alternative fuel. In this case, the values have been compared with the import parity price of naphtha now in vogue and also with export parity price of naphtha which is a possibility in future when the naphtha surplus increases. For the price profile of the demand from this sector we have used only the first set of values. The other values are meant for comparison.

Creditworthiness

- In the fertiliser sector the plants are owned by reputed companies such as Tata, Oswal, Birlas, Duncans and the Sriram group. In the public sector, the concerned units belong to IFFCO and KRIBHCO, both well managed and profitable companies.
- Unlike the power sector where the progress of reforms is crucial to the viability of power producers, reforms in urea pricing will create problems for urea producers in the short run by exposing them to competition. While naphtha based units will have to change to gas, it is expected that gas based units will be able to negotiate the required level of protection and to expand

production capacity. Food security being important to the government, urea producers have a lot of leverage.

- In the absence of protection, none of the units would be viable against imported urea.
- Even with protection against imports, not all the producers may do well under competition. However, all of them have established brand names and marketing networks and no major changes in the market shares are foreseen at present.

Industry

Demand

- The industrial demand has been estimated for the cement, paper and the glass industries. These are the energy intensive industries in these states. The demand from only the large and modern units have been considered. This increases the chances of actually tapping the demand at least along the pipeline route. A more accurate assessment of demand from this sector can be made only with a detailed field survey.
- Paper mills in India are using gas but cement units are not. The conversion of cement units would require the introduction of a new technology. This is possible and will increase the efficiency of these units and their ability to pay for gas.

Imputed values

- The comparison in these cases is straightforward, based on calorific values. For the cement and paper industries, industry grade coal has been taken as the alternative fuel. Fuel oil is also used in these units but only to a small extent. For glass units, LPG is the alternative fuel.
- Industry in Gujarat is now paying a gas price of Rs 2850/thousand cubic metres which equals $1.56/MMBtu. In addition they pay royalty of 10% ($0.16/MMBtu) and transport charges depending on location. The domestic gas price is due for a revision and may soon exceed $3/MMBtu. The consumers will not surrender their allocations and change to coal. Indications are that most of them would continue to use gas. The imputed value of $1.83/MMBtu calculated for industrial units, therefore, underestimates the price they would be willing to pay.
- It is possible for cement units to reduce energy consumption from 930 kcals/kg, assumed by us in computing the imputed value, to 700 kcals/kg. There are additional benefits in terms of savings in power consumption,

refractory consumption and clinker quality in changing over to gas. Cement producers should be able to pay between \$2.9–3.6 / MMBtu depending on location.

Creditworthiness

- Only the large and modern units will come forward to take expensive LNG-gas and these units are expected to be creditworthy. However, this has to be established individually.

Captive generation

Demand

- Captive generation is limited mostly to large industrial consumers, especially those in process industries. Coal, naphtha, diesel and gas are all used as fuels for captive units.
- We use the growth in captive generation projected in the 16th EPS with some modifications for the states where the projected reduction is too sharp.
- In this case also we think of two scenarios. In the high reform scenario the growth in captive generation will be low. This is not because the regulators are discouraging captive capacity; on the contrary the central government is exhorting the states to encourage captive power to meet the likely shortages. The regulators are expected to rationalise power prices by removing the heavy subsidy that is now borne by industrial customers. This will reduce captive generation in the high reforms case.
- In 2006/7 we have taken the gas demand from captive units changing over from naphtha. We have assumed that one-third of the naphtha capacity will be willing to change over. Thereafter, we assume that one-third of all capacity additions will be gas based.

Imputed values

- The imputed values for captive generation have been calculated against domestic naphtha priced on import parity basis. These prices are fixed by the oil companies separately for each refinery. We have used the prices ex-Mathura and Koyali refineries and have not included the transportation costs from the refineries to the consumer. To that extent the imputed values are underestimated.

Creditworthiness

- Same as that for industrial demand.

City distribution

Demand

- Gas use for city distribution is rather low in India. Gas is used only for cooking and the daily demand from households is only around 1 cubic metre. Gas grids can be viable only in the large cities and that too where commercial and industrial load can provide the anchor. Typically, in any city distribution project, the industrial and commercial load would be above 60% of the total demand. The demand estimates including the commercial and industrial demand and the viability analysis for city distribution projects require field level surveys.
- The data on population in urban clusters is available only from the 1991 census. This data has been examined along with available data on growth rates to identify the towns/cities with populations above two million.
- In estimating the load in the residential sector we have used penetration ratios established in recent surveys and utilised the experience of gas distribution projects in Delhi and Mumbai.

Imputed values

- The residential sector has a high imputed value as the alternative fuel is LPG and the subsidy on domestic LPG is on the way out. The cost of LPG has been estimated ex Mathura and Koyali as in the case of naphtha. There is therefore an element of underestimation in the imputed values.
- The commercial units and small industries use fuel oil and light diesel oil. The imputed values for these sectors have not been estimated.

Creditworthiness

- The commercial load comes mainly from large hotels which should not pose a problem as the hotel industry is doing well. The creditworthiness of small industrial units have to be ascertained through field survey.

Demand profiles

The time profile and the price profiles of the incremental gas demand to be met by imports would be as below.

Table 3 Sector-wise incremental gas demand

Scenarios	Power	Urea	Industries	City distribution	Captive generation	Existing consumers	Total (MMCMD)	Total (mt)
High reforms								
2006/7	20.41	6.92	8.33	1.29	1.88	7.38	46.21	11.55
2011/12	28.61	14.42	11.16	2.50	3.40	18.06	78.15	19.54
Low reforms								
2006/7	10.45	6.92	8.33	1.29	2.67	7.38	37.04	9.26
2011/12	16.89	9.92	11.16	2.50	6.71	18.06	65.24	16.31

The total demands (MMCMD) in the two scenarios are plotted below.

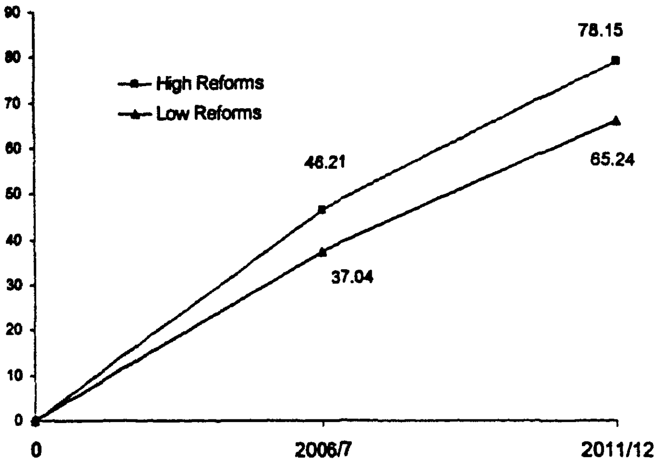

Figure 1 Total potential gas demand - high reforms and low reforms cases

Table 4 Price profile of the incremental demand (High reforms - 2006/7)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		0.77	0.77	7.44	2.46
Captive generation		0.47	1.24	6.25	2.46
Power, Punjab		0.82	2.06	5.12	-
Power, Gujarat		1.31	3.37	5.07	1.97, 2.46
Urea	Existing	0.62	3.99	5.05	2.46
Urea	Conversion	1.73	5.72	4.85	-
Power, Haryana		0.39	6.11	4.83	2.46
Power, Delhi		0.50	6.61	4.74	2.46
Power, UP		0.62	7.22	4.64	2.46
Power, Rajasthan		0.89	8.11	4.39	-
Urea	Expansion		8.11	4.24	-
Power, MP		1.36	9.47	3.53	-
Cement, Paper		2.08	11.55	1.83	1.97

Table 5 Price profile of incremental demand (High reforms - 2011/12)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		1.26	1.26	7.44	2.46
Captive generation		0.85	2.11	6.25	2.46
Power, Punjab		0.40	2.51	5.12	-
Power, Gujarat		3.01	5.52	5.07	1.97, 2.46
Urea	Existing	1.51	7.03	5.05	2.46
Urea	Conversion	1.73	8.76	4.85	-
Power, Haryana		0.37	9.13	4.83	2.46
Power, Delhi		1.13	10.25	4.74	2.46
Power, UP		1.79	12.04	4.64	2.46
Power, Rajasthan		0.51	12.55	4.39	-
Power, MP		1.60	16.02	3.53	-
Cement, Paper		3.52	19.54	1.83	1.97

Table 6 Price profile of incremental demand (Low reforms - 2006/7)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		0.77	0.77	7.44	2.46
Captive generation		0.67	1.44	6.25	2.46
Power, Punjab		0.00	1.44	5.12	-
Power, Gujarat		0.82	2.26	5.07	1.97, 2.46
Urea	Existing	0.62	2.88	5.05	2.46
Urea	Conversion	1.73	4.61	4.85	-
Power, Haryana		0.06	4.67	4.83	2.46
Power, Delhi		0.56	5.23	4.74	2.46
Power, UP		0.46	5.69	4.64	2.46
Power, Rajasthan		0.81	6.50	4.39	-
Urea	Expansion	0.00	6.50	4.24	-
Power, MP		0.58	7.08	3.53	-
Cement, Paper		2.08	9.16	1.83	1.97

Table 7 Price profile of incremental demand (Low reforms - 2011/12)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		1.26	1.26	7.44	2.46
Captive generation		1.68	2.94	6.25	2.46
Power, Punjab		0.00	2.94	5.12	-
Power, Gujarat		1.75	4.68	5.07	1.97, 2.46
Urea	Existing	1.51	6.19	5.05	2.46
Urea	Conversion	1.73	7.92	4.85	-
Power, Haryana		0.15	8.07	4.83	2.46
Power, Delhi		1.19	9.27	4.74	2.46
Power, UP		0.94	10.21	4.64	2.46
Power, Rajasthan		1.14	11.35	4.39	-
Urea	Expansion	0.75	12.10	4.24	-
Power, MP		0.70	12.79	3.53	-
Cement, Paper		3.52	16.31	1.83	1.97

- The current gas price is the same for all categories of consumers. It is $1.97/MMBtu in Gujarat and $2.46/MMBtu along the HBJ pipeline.

How firm are these demand numbers?

- The deficit projected for existing customers is based on production profiles prepared by ONGC. ONGC has no reason to underestimate the production potential. In fact these estimates include some expectations from future discoveries. The projected deficits should accordingly be taken as conservative.
- One of the fall-outs of the Dabhol crisis has been that power demand numbers are under closer scrutiny than before. The power procurement plans of utilities are being challenged before the regulators. We have taken a level of demand which is conservative enough to pass this scrutiny and the resulting gas demand is robust.
- The demand for urea is also conservative. Even in the low reforms scenario, the government will try its best to persuade the naphtha based units to change to gas in order to reduce the subsidy and the naphtha conversion demand could materialise before 2010. The demand from expansion plants is relatively less certain in the low reforms case.
- The demand from the cement industry is not firm as a new technology would have to be introduced. The demand from paper mills and glass units is firm.
- The demand for captive generation is good quality, high value demand and would be targeted by Dahej and other suppliers.

- The city distribution demand is underestimated due to the omission of commercial and small industrial demand but the certainty of the demand for city distribution has to await a detailed survey and at this stage the demand numbers can only be taken as indicative.

How firm are the imputed values?

- There are many uncertainties in the calculation of the imputed values which are expected to be exploited by both sides during price negotiations. The principal difference in the imputed values for power and fertilizers is likely to be over efficiencies.
- For the power sector we have adopted 56% efficiency of gas turbines. Many power producers in India are more comfortable with 52% efficiency although 56% is now being guaranteed for India. This may lead to a difference of around 30 cents / MMBtu in the imputed values.
- For gas based urea production we assume that 5.4 Gcals are required for 1 MT of urea, whereas most urea producers favour 6 Gcals / MT of urea. This leads to a reduction of 40 cents / MMBtu in the imputed value of $4.2 / MMBtu computed by us for expansion units. There is a similar difference for units converting from naphtha to gas.

Demand-supply analysis

With increasing demand for gas and declining supplies from domestic sources, the demand-supply deficit will increase as shown below.

Table 8 Demand -supply of gas (million tonnes)

Demand / supply		2001/2	2006/7	2011/12
Demand	High reforms	14.76	24.47	29.78
	Low reforms	14.76	22.18	26.55
Supply	Gujarat-ONGC	1.52	0.73	0.17
	Gujarat-non-ONGC	0.08	1.25[a]	2.00[b]
	Western-offshore	9.19	10.93[c]	8.07[d]
	Total	10.78	12.91	10.24
Deficit	High reforms	3.97	11.56	19.54
	Low reforms	3.97	9.26	16.31

[a] Includes 0.75 mt from Hazira field of GSPCL and 0.50 mt from offshore field of Cairns Energy. The production is scheduled to reach 1.0 mt by 2003 and 1.25 mt by 2004;

[b] Includes 1.0 mt each from GSPCL and Cairns. Output from Cairns could go up to 2.0 mt;

[c] Includes a production of 0.37 mt from anticipated reserves;

[d] Includes a production of 1.25 mt from anticipated reserves

Alternative gas supplies

Iran - India pipeline

- The wellhead price of gas in Iran is expected to be around $0.80/MMBtu including desulphurisation. The transportation charges for an onland route involving a 2400 km pipeline would depend primarily on the volume.
- For a 1 bcfd (7.1 mt) pipeline this comes to $2.20/MMBtu but for a 3 bcfd (21.3 mt) pipeline, this drops to $1.30. The transit fee payable to Pakistan for the 800 km pipeline within Pakistan would come to 40 cents/MMBtu. The border price of gas, therefore, comes to $2.50/MMBtu. The estimated price is more or less the same for a shallow water pipeline through Pakistan's EEZ but outside the territorial waters as the transit fee is no longer payable.
- The onland pipeline enters India through Rajasthan and the offshore pipeline enters through Gujarat. It could thereafter be fed into the HBJ for an additional cost of $0.20/MMBtu or taken to the consumers through a new pipeline with an additional transportation charge of around $1.00/MMBtu.
- This project has not made any progress with Pakistan favouring an onland route and India insisting on a simultaneous feasibility study for both the onland and a shallow offshore route. India has always been troubled by the question of security of supplies and has opposed the onland route on this ground. Recently however there has been a change in the Indian stand and it seems that the Indian government is not totally against the onland route. In the context of the current state of Indo-Pak relations the pipeline alternative from Iran has to be taken as a low probability supply source.
- It may be argued that LNG would improve the security of this project. There is no doubt that the risk perception would change and minor disruptions in the supply could be taken care of. The other ways of improving the security of the project would include having gas storage of 15 days' requirement. However, it is not likely that a US or UK like situation would develop with cheaper pipeline gas flooding the market while LNG terminals became stand-by facilities. The ability of the Indian consumer to pay for redundancies is strictly limited.

Bangladesh - India pipeline

- Two options for the Bangladesh pipeline have been proposed, one from the offshore fields and the other from the onshore fields in north Bangladesh. Unocal has recently proposed a 500 mcfd (3.5 mt) pipeline from the Bibiyana onshore field in Bangladesh to be fed into the HBJ pipeline. The

1350 km 30 inch diameter connection from Rashidpur to the HBJ is estimated to cost $910 million. The transportation cost would be around $0.60/MMBtu. With a wellhead gas cost of $2.2/MMBtu, the delivered price in the western states comes to $ 3.30/MMBtu (with $0.5/MMBtu along the HBJ).

- The Bangladesh government has so far turned down all proposals for gas exports to India on the ground that the gas is required for use in Bangladesh. Recently the government is reported to have decided that export would be allowed only when the proven reserves exceed fifty years' requirement. The present proven reserve is 11 tcf (312 BCM) and it is not likely that exports would be cleared before it reaches 30 tcf (850 BCM). The United States Geological Survey has recently assessed the probability of another 9 tcf (255 BCM) as 95%. However, this gas is yet to be discovered.
- US pressure on Bangladesh for exports is likely to be stepped up after the elections to be held soon. However, no immediate breakthrough is likely. Besides, Bangladesh would prefer to start small with exports being agreed for specific projects in eastern India. Accordingly, Bangladesh also is considered a low probability source for the purpose of the present study.

LNG at Dahej

- With an fob price of around $2.30/MMBtu (at a crude price of $18/bbl), a shipping cost of 30 cents and a regas cost of 40 cents, gas should be available at $3.00/MMBtu ex-Dahej. This gas should reach the consumers in the western states at $4.00/MMBtu or less.
- With the gas supply agreement, the shipping contract and the EPC contract tied up, Dahej is highly likely to keep the target date of 2004/5. The problem is that the LNG price is linked to crude oil and there is no price cap. The consumers are not willing to accept open ended prices. As a result, Petronet is yet to firm up any gas sales contract. Pooling the price with domestic gas is being considered as a way out of this problem.
- Petronet has agreed the supply of 7.5 mt of LNG with Rasgas. Out of this 2.5 mt was earmarked for Kochi in the south but Petronet has the choice of importing the entire quantity at Dahej. It is not likely that Kochi will come up on schedule. Although the shortlisting of EPC contractors is being taken up for Kochi, no contract will be awarded before sufficient gas demand is identified. Petronet may therefore have to import the whole quantity at Dahej.

- Petronet has a strong incentive to go beyond that and bring 10 mt to Dahej to use scale economies. It is reported that expanding the terminal to that capacity would require only $70 million more.

LNG at Hazira

- Shell has proposed a 5 mt terminal at Hazira in Gujarat. The announced date of commissioning is 2004/5. LNG is proposed to be sourced from Shell's own projects in Australia, Malaysia or Oman. The work of tendering is in progress for Hazira.
- Attempts by the promoters to get access to the HBJ for the imported gas have not succeeded. Shell is accordingly concentrating on Gujarat. Shell's proposal for taking equity in a pipeline project of Gujarat Petronet is yet to be approved by the government.
- Shell is reportedly cutting costs aggressively to compete against Dahej. They perceive an early start to be of advantage and plan to start construction of the terminal without insisting on contracts for gas sales. They are keenly awaiting the outcome of the gas pricing exercise going on in GAIL.

LNG at Pipavav

- Seaking Infrastructure Limited, the developer of the Pipavav port in Gujarat and British Gas have formed the Gujarat Pipavav LNG Limited to set up an LNG terminal at Pipavav. The initial proposed capacity of 2.5 mt is expandable to 10 mt. The company has signed an MOU with Yemen LNG for 5.3 mt of LNG. It has proposed a 150 km sub-sea pipeline to connect the terminal to the important gas consumers in Gujarat. The company also proposes to use of the gas grid of their affiliate, the Gujarat Gas Company. The project was to rope in NTPC as a partner but NTPC has since decided not to join any LNG project. This project is not at par with Dahej or Hazira and can only be considered a low probability gas source although some interest in the project was generated recently when BG acquired the shares of Seaking in the project.

Gas fields in Gujarat

- GSPCL which acquired a small gas field in Hazira in 1995-96, has found enough gas to sustain a production of 3–4 MMCMD (0.75–1 mt). Cairns Energy which is working on an exploration block in offshore Gujarat has announced the discovery of three gas fields and are negotiating the sale of 2 MMCMD (0.5 mt) from these fields. We consider 5 MMCMD (1.25 mt) as a high probability supply by 2006/7. This may go up to 8 MMCMD (2 mt) by 2011/12.

Dabhol

- The Dabhol terminal has a capacity of 5 mt under construction. The Dabhol power project needs only 2.1 mt and the rest was to be marketed in Maharashtra. Enron did consider a capacity of 10 mt with a view to taking gas all the way to Hazira. With a sales tax differential of around 70 cents/MMBtu and the Dabhol power project absorbing the regas cost, the extra transportation cost could be taken care of. However, the power tariff for Dabhol may be renegotiated and sales tax rates are not stable enough to provide the basis for a long term gas supply project. Dabhol need not now be considered as a gas source for Gujarat.
- Power from the Dabhol power project is on offer for interested states. Delhi and Punjab have shown interest in this power but it is unlikely that the price would be acceptable to these states.

Good quality demand

- The good quality, creditworthy demand available irrespective of the progress of reforms would be as below:

Table 9 Good quality demand (million tonnes)

Sector	2006/7	2011/12
Existing	1.85	4.52
Power	1.90[a]	4.22[b]
Fertiliser	1.73[c]	3.61
Industry	0.83[d]	1.03[d]
Captive	0.47	0.85
City	-	-
Reliance	0.73	1.21
Total	7.51	15.44

[a] 1950 MW to be set up by NTPC has been counted towards creditworthy power sector demand;

[b] Limited to the demand projected for the low reforms case once again counting only units to be set up by NTPC;

[c] Even if urea price decontrol is delayed, government will persuade naphtha based producers to change to LNG when available. Accordingly, demand from naphtha conversion should materialize independently of reforms;

[d] Only cement units in Gujarat and glass units considered as they can pay prices above $3/MMBtu.

- The Dahej project, with access to HBJ and the local Gujarat networks, is best placed to meet the entire deficit for existing consumers. However, it is the delivered cost to the consumer, which would be decisive.

- Hazira LNG would be a close competitor for Dahej in Gujarat.
- The proposed Reliance pipeline (Map) would have an advantage in western Gujarat, Rajasthan and eastern Uttar Pradesh while Dahej would have the advantage in eastern Gujarat, western Madhya Pradesh, western Uttar Pradesh, Delhi, Haryana and Punjab.
- The Reliance refinery has a demand of 0.48 mt for captive power and another 0.25 mt for use as a heating fuel. With the proposed capacity expansion coming through, the demand may go up to 1.21 mt. This is a captive, bankable demand for the Jamnagar LNG project.

Netback prices

- The imputed value for urea producers converting from naphtha to gas is $4.85/MMBtu while that for capacity expansion is $4.2/MMBtu. It would be difficult to negotiate different gas prices for the two groups as these prices would need the approval of the same authority - the Fertiliser Ministry. Only the transport cost could be different depending on location.
- We envisage some difficulty in getting different prices even from power producers as Indian consumers are used to prices based on cost of delivery and not opportunity costs. Power sector regulators who approve the PPAs may also agree only to cost-plus prices.
- The expected netback would therefore be the same from all consumers. With a delivered price of $4.2/MMBtu in UP and a probable transport cost of $1-1.2/MMBtu (compared to $0.74/MMBtu along the HBJ), the netback should be $3-3.2/MMBtu.
- The imputed value for power in Gujarat may exceed $5/MMBtu at coastal locations but that is for power produced and consumed in Gujarat. If power is generated in Gujarat and shipped to MP, UP, Delhi and beyond, a lower price would be available. Taking a power transmission cost of 0.65 cents/kwh, power to Haryana and Punjab could compete with power from Hirma if the generation cost was 4.3 cents/kwh. At 52% efficiency, this would require a gas price of $3.5/MMBtu. Assuming a transmission cost of $0.25/MMBtu, the netback from this would be around $3.25/MMBtu which matches the prices derived above for the fertiliser sector.
- Any reduction in the transport cost will improve the netback.
- Privately produced gas is on offer in Gujarat at about $3.5/MMBtu.

Pooled pricing by GAIL

- At present, GAIL buys gas at different prices from ONGC, Enron and Cairns Energy and sells the gas at a pooled price. The consumer price is linked to fuel oil prices and varies between a cap of $1.56/MMBtu and a floor of $1.18/MMBtu. Enron and Cairns are paid fuel oil parity prices subject to caps of $3.11/MMBtu and $3/MMBtu. Out of the total sale proceeds, the private producers are paid first and ONGC gets a residual price, currently around $1.3/MMBtu.
- Pooling has worked so far because the proportion of the costly gas has been small. It is now around 8 MMCMD (2 mt) out of 60 MMCMD (15 mt).
- It is understood that GAIL has proposed pooling of prices of domestic gas and LNG as consumers are not willing to buy LNG at the offered prices linked to crude oil prices, especially as there is no cap. Pooling in such a high volume of costly gas looks difficult. It will be resisted by the consumers who are aware that LNG may be available at cheaper prices.
- Petronet may have to try the alternative of renegotiating the LNG price with Qatar before pooling is agreed to by the government.
- Even if GAIL pools the price, the netback calculated above (based on imputed values) could still be available. As noted above, ONGC gets a residual price and will resist any lowering of the consumer price below the opportunity cost of the consumers.

Prospects for Iran LNG

- The project must compete with Petronet, a strong contender for the same market. Inspite of the advantage of the HBJ pipeline, Petronet has not found buyers for the gas. This shows that the gas price would be crucial to the success of the Reliance project.
- Hazira LNG, with its emphasis on cost cutting will be a strong competitor in Gujarat.
- The power sector is the largest potential consumer. None of the SEBs can sign bankable PPAs at present. The progress of reforms is crucial to the creditworthiness of this sector.
- Assuming that all existing gas consumers will be covered by GAIL / Dahej, Iran LNG can expect a reliable demand of 5.66 mt by 2006/7 and 10.92 mt by 2011/12.
- The gas price, if linked to crude, must have a ceiling. An open-ended price would not be accepted.
- The expected netback is $3 to $3.2 per MMBtu.

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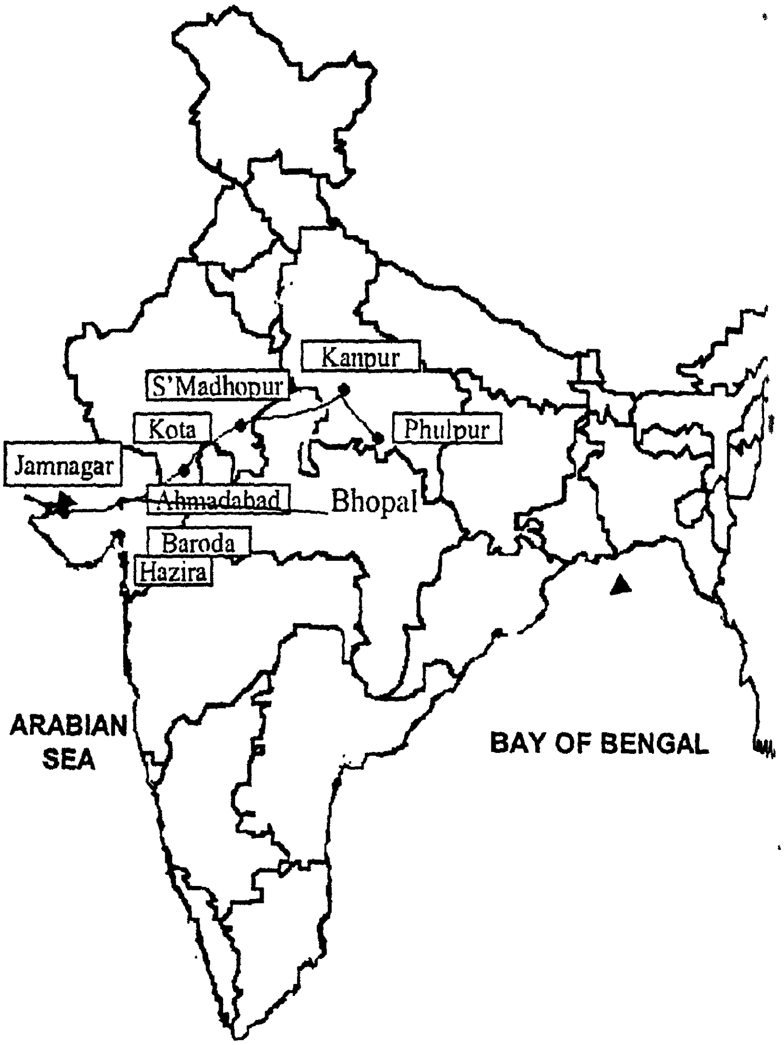

Map Showing HBJ and proposed Reliance pipeline

1

Overview of the Indian gas industry

Oil and gas were discovered in India in 1886 in Upper Assam. The Naharkatyia oilfield in Assam was the first oil and gas discovery of independent India in 1953, followed by the Moran field in 1956. Commercial utilization of natural gas in India started in the early sixties in Assam but really picked up after the development of the giant Bombay high field in the early eighties. Subsequently, South Bassein, another very large gas field was discovered in 1978 in the western offshore basin and brought into production around 1990.

The early focus was on oil production and as a result large amount of associated gas from producing oil fields was flared due to a lack of infrastructure and markets. Free gas field finds were shut in for the same reason.

It was only in the early 1980's that the western offshore gas began to be exploited as a resource rather than being treated as a by-product. The government appointed a number of committees and expert groups to examine the ways in which the gas could be best utilised. The view that emerged was that the optimal use of gas would be in producing fertilisers. Initially there was quite some opposition to the use of gas for power generation but later the idea was accepted. In 1986 work began on the Hazira-Bijaipur-Jagdishpur (HBJ) gas transmission line linking the western offshore gas fields with fertiliser and power plants (Map 1.1). This resulted in a significant growth in gas production and use through the late 1980's. Flaring from the western offshore has diminished substantially in recent years and is now limited to only technical flaring. While the bulk of the western offshore gas is brought to Hazira, a part of it is taken to Uran in Maharashtra for use by power plants, urea plants and industries around Mumbai.

In the north-east, gas is produced in Assam, Arunachal Pradesh and Tripura. Associated gas has been produced in Assam for over 20 years but flaring has remained at high levels till recently. Free gas fields in Tripura are being used mainly for power generation. Some associated gas is being produced in Arunachal Pradesh but utilisation by a proposed gas-to-liquid plant is yet to start. Consequently, this gas has to be flared.

Next to Gujarat and the north-east, Andhra Pradesh has the largest gas reserves. Gas from ONGC's onshore fields and the offshore Ravva field is being used in producing urea, power generation and in industry. ONGC has made a number of discoveries in the area recently and gas has been allocated by the government for new power plants with a proposed capacity of 1800 MW. Cairns Energy has recently announced a discovery in an offshore field named Annapurna from where they expect a peak production of around 5 MMCMD. There is an expectation of more gas finds in the area as exploration proceeds in the NELP blocks. Rajasthan and Tamil Nadu also use gas in small quantities.

Gas reserves and production

Gas reserves

The balance recoverable reserves of natural gas increased steadily from 1975 to 1999 but are now declining.

Table 1.1 State-wise reserves of natural gas (BCM)

Gas reserves (BCM)	1975	1980	1985	1990	1995	1998	1999 (P)
Onshore							
Gujarat	15.72	16.39	21.87	92.58	89.88	84.24	-
Assam	65.24	63.53*	87.67*	135.47*	159.18*	187.73	-
Rajasthan	0.43	0.43	0.54	1.04	4.11	4.44	-
Total	81.39	80.95	110.08	229.09	253.17	276.41	279
Offshore							
Bombay High	6.28	270.96	368.55*	457.36	406.47**	398.34	369
Grand Total	87.67	351.91	478.63	686.45	659.64	674.75	648

* includes natural gas reserves in Tripura, Nagaland Tamil Nadu, Arunachal Pradesh & Andhra Pradesh

** includes natural gas reserves in Andhra Pradesh, Gujarat, Tamil Nadu, Andaman and JVC

Source. Indian Petroleum & Natural Gas Statistics - 1997-98 and 1998-99, Ministry of Petroleum & Natural Gas, Govt. of India

According to the Ministry of Petroleum and Natural Gas, the onshore and offshore gas reserves in the country in 1998 and 1999 were as follows.

Table 1.2 Gas reserves in 1998/99 (BCM)

Natural gas reserves	1998	1999
Onshore	277	279
Offshore	398	369
Total	675	648

Source. Indian Petroleum & Natural Gas Statistics - 1997-98 and 1998-99, Ministry of Petroleum & Natural Gas, Govt. of India

Unless reserves in existing fields are significantly upgraded or new fields discovered and brought on stream, gas production is set to decline from its current level.

Gas production

Natural gas production in India has grown from 2.4 BCM in 1975/76 to 27.4 BCM in 1998/99.

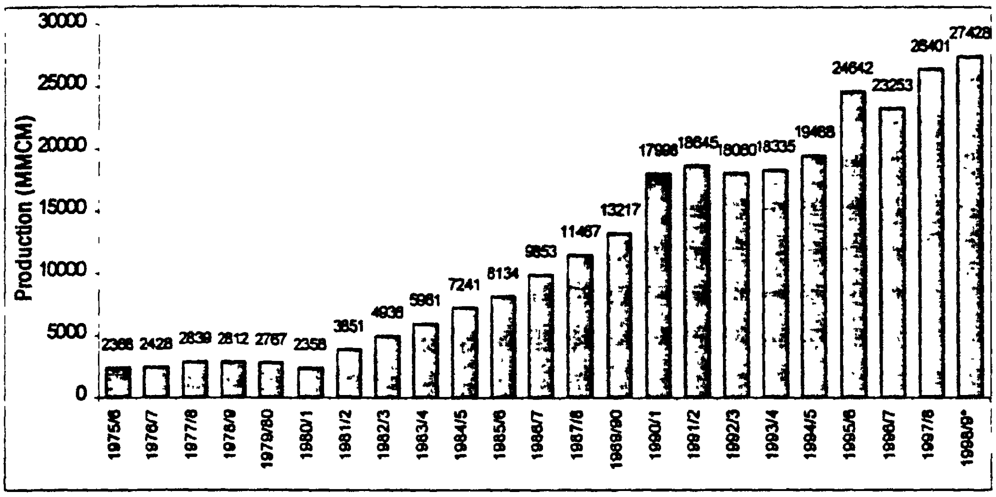

Figure 1.1 Gas production in India in million cubic metres
Source. Indian Petroleum & Natural Gas Statistics - 1997-98 and 1998-99, Ministry of Petroleum & Natural Gas, Govt. of India

There are five major areas of gas production in India today:

- The Western Offshore region which extends from offshore Bombay to Gujarat
- North and South Gujarat
- The Krishna Godavari basin in Andhra Pradesh
- The Cauvery basin in Tamil Nadu
- Assam and Arunachal Pradesh

Currently around 75% of India's gas is being produced from the western offshore fields.

as supply sector organization

The gas supply sector in India is dominated by public sector enterprises under the administrative control of the Ministry of Petroleum. Ninety percent of the gas is produced by two state owned oil companies, the Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL). The balance comes mostly from the medium sized fields - Panna, Mukta and Tapti in the western offshore and Ravva off the Andhra coast - operated by joint ventures of ONGC. Several small gas fields operated in the private sector are also producing gas but their production does not add up to much.

The gas produced by ONGC and the joint ventures is marketed by GAIL. OIL, which operates mainly in Assam and also in Rajasthan has its own marketing arrangements. GAIL and OIL sell gas only to consumers who are allocated gas by the Government of India while the private operators are free to select their customers. The gas price to be charged by ONGC and OIL and the transportation charges along the HBJ pipeline of GAIL are fixed by the government. Gas from private fields is sold at negotiated prices.

he gas industry infrastructure

The Hazira-Bijaipur-Jagdishpur (HBJ) gas pipeline network is the major gas transmission line in India, owned and operated by the Gas Authority of India Limited (GAIL). It starts at Hazira in Gujarat and passes over Rajasthan, Madhya Pradesh, Uttar Pradesh into Haryana. It is 2300 km long with a capacity of 33.4 MMCMD. Spur lines at various points in Gujarat, Rajasthan, Uttar Pradesh, Delhi and Haryana feed power plants, fertiliser plants and industries.

Wet gas from the offshore South Bassein field, off the coast of Maharashtra, is fed by 216 km sub-sea lines of 36" and 42" diameter to ONGC's sweetening and fractional separation plant at Hazira. The gas handling capacity at the Hazira terminal is 41 MMCMD.

With several LNG terminals being planned on the west coast of India, GAIL plans an investment of Rs. 30 billion to expand the HBJ capacity to 60 MMCMD by 2003. GAIL also plans to extend the HBJ pipeline to Ludhiana in Punjab.

In addition to the HBJ pipeline, there are regional gas grids of varying sizes in the states of Gujarat, Andhra Pradesh, Assam, Maharashtra, Rajasthan, Tamil Nadu and Tripura. Most of these regional pipelines (about 725 km) were constructed and operated by ONGC but ownership and operation of these gas grids were passed on to GAIL in the nineties. The present grid capacity is based on the gas availability from the producing areas as well as the outlook for future gas production. In view of the increased availability of gas in the KG basin, GAIL has announced plans for augmenting pipeline capacity in Andhra Pradesh.

Distribution

The Mahanagar Gas Limited, a joint venture between GAIL and British Gas is supplying gas to around 50,000 houses in Mumbai as well as small industrial and commercial units and CNG filling stations. The Indraprastha Gas Limited, a joint venture of GAIL and BPCL is supplying gas in Delhi to around 1000 houses and 80 CNG stations. At the instance of the Supreme Court, the fleet of buses, taxis and rickshaws in Delhi is being converted to CNG. The other cities with natural gas distribution systems are Vadodara, Surat and Ankleshwar in Gujarat and a few towns in Assam and Tripura in the north-east.

Exploration prospects and present activity

Sedimentary basins in India

There are 26 sedimentary basins in India extending over 1.39 million square kilometres onshore, 0.4 million square kilometres offshore and about 1.35 million sq. km in deep waters.

The basins have been categorized according to their prospectivity; Category I consist of producing basins, while Categories II to IV are basins with reducing prospectivity. The Category I basins include:

- Cambay Basin, Gujarat
- Bombay Offshore
- Cauvery Basin
- Krishna-Godavari Basin
- Assam Shelf/Assam Arakan Fold Belt

Exploration during the 1960s and 1970s was concentrated in category I basins. The three main producing basins in the country, the western offshore region, the Cambay basin in Gujarat, and Upper Assam region, are in the mature phase of exploration and with the exception of Assam, future finds in these areas are not likely to be large in size. The deep water basins now being explored hold some promise of large discoveries.

Although the state owned enterprises increased hydrocarbon production and the reserve base significantly over the period 1975 to 1990, the gap between domestic production and demand widened in the later years. As a result, steps were taken to encourage private sector investment into exploration and production with exploration acreage offered to private companies under production sharing arrangements with the Indian government. Nine rounds of bidding were followed in 1999 by the New Exploration Licensing Policy (NELP) offering a level playing field to private and public sector oil companies. The first round of the NELP was launched in 1999. 25 blocks from this round were awarded last year and these have started showing results with discoveries offshore Gujarat and Andhra Pradesh. Exploration in the other blocks is in progress. With $250 million committed to be spent by the exploring companies, there is expectation of more oil and gas finds. The blocks under the second bidding round launched in late 2000 are expected to be awarded soon.

Alternative sources of gas

Coal bed methane (CBM)

The production of natural gas from coal – coal bed methane (CBM) – has been undertaken in several countries over the last decade, especially in the United States. India holds significant prospects for exploitation of CBM as a new source of energy. There are about 200 billion tonnes of coal reserves predominantly in the eastern part of India – Bihar, West Bengal and Madhya Pradesh. It is estimated that 70 –75 billion tonnes of coal reserves are beyond 600 metres in depth and thus not extractable with the current mining technologies. These reserves would potentially be available for exploitation of CBM. The existence of gaseous mines is well established in India, notably in Damodar Valley coal fields in Bihar and Bengal. Analysis of the coal in the Damodar Valley has indicated that upto 10 cubic metres of methane gas per tonne of coal may be present at a medium depth of burial.

There are large lignite reserves in Gujarat at the depth of 1,000 – 1,500 metres. GAIL and ONGC have agreed to jointly undertake a project for assessing the CBM potential of coal deposits in north Gujarat.

After taking into account the future coal- mining programme by coal companies, 7 blocks have been offered for exploration and exploitation through global competitive bidding by the government. The prognosticated CBM resource in these blocks is around 400 BCM as estimated by the Director General of Hydrocarbons (DGH).

Table 1.3 Prognosticated CBM resources

Coalfield	Block/State	Area covered (in sq k.m.)	Prognosticated CBM resource (in TCF)
Gondwana Coal			
Raniganj	Norhtern Raniganj (West Bengal)	232.00	1.030
Raniganj	Eastern Raniganj (West Bengal)	500.00	1.850
Jharia	Southern part of Jharia Coalfield (Bihar)	69.20	2.407
Bokaro	Bokaro Basin (Bihar)	93.97	1.590
Birbhum	Birbhum (West Bengal)	250.00	1.000
N. Karanpura	N. Karanpura (Bihar)	340.54	2.181
Sohagpur	Eastern Sohagpur (M.P)	495.00	3.030
Sohagpur	Western Sohagpur (M.P)	500.00	
Satpura	Satpura Basin (M.P)	500.00	1.000
Total		2980.71	14.088 or 398 92 BCM gas in place

Source. Hydrocarbon Vision 2025, GoI

These resources can yield an average production level of 22 MMCMD for a period of 25 years, assuming a recovery factor of 60%. The last date for submission of bids is August 31, 2001. The blocks are like to be awarded by the year end.

Demand for natural gas

Past trends in gas demand

Although the use of natural gas has increased rapidly, natural gas accounts for only around 11% of the primary energy in use. Till the late 1980s the demand lagged behind the production potential mainly because of lack of infrastructure. However, in the 90's, the demand has exceeded the supply.

In view of the shortage of gas, the government of India allocates gas to all consumers. The power and fertilizer sectors have been allocated most of the gas. These two sectors together consume about 80% of the gas today. The sponge iron units consume another 10%. The balance goes to industrial units where it replaces mostly fuel oil and some LPG also. As noted earlier, gas is also supplied to the residential and the commercial sectors in Mumbai, Delhi and a few towns of Gujarat, Assam and Tripura. This gas is used for cooking only, as space heating is not required. The daily requirement of households is only around 1 cum. With such low requirements and the subsidy on domestic LPG, the demand from this sector will continue to be low. The use of CNG in lieu of petrol has been popular in Mumbai and Delhi.

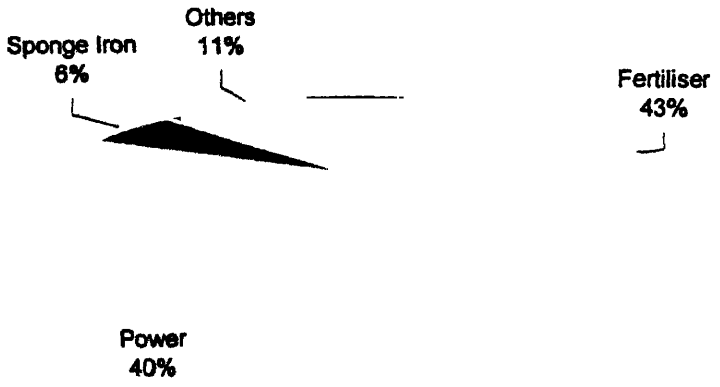

Figure 1.3 Sectoral gas sales (1998/99)
Source. Petroleum Statistics - MoPNG

Area wise and sector wise use of natural gas in 1998/99 was as shown in the Table below:

Table 1.4 Gas utilization: 1998/99 (MMCMD)

Area	Fertilizer	Power	Sponge Iron	Others	Total
Western Offshore					
Uran	5.0	4.7	1.4	0.7	11.8
HBJ	13.0	9.1		2.5	24.6
Hazira	2.7		2.0	1.2	5.9
Western Onshore	1.2	4.2		1.4	6.8
Rajasthan		0.4			0.4
K. G. Basin	1.7	2.2		0.1	4.0
Assam	0.0	0.4		0.1	0.6
Tripura		0.8		0.0	0.8
Cauvery Basin		0.0		0.1	0.1
Total	23.6	21.9	3.5	6.1	55.1

Source. GAIL

Among the states, Gujarat uses more gas than any other state in India.

Gas use in fertilizer industry and power generation

The fertilizer industry is currently the largest single gas consumer in India accounting for about 44% of the total sales. Gas utilization for fertilizer production in India started in earnest in the early 1980s.

The choice of feedstock for fertilizer production has been primarily determined on the basis of availability of feedstock and government policies in place. The demand for gas for fertilizer production, however, exceeds domestic availability. Immediately following the fertilizer industry, the power sector is the second largest consumer of gas in India.

Other industries

Gas utilization is preferred in industries where heat control and low sulphur are prerequisites in the fuel used such as glass, ceramics, textiles, electronics (picture tubes) etc. It is also used in the sponge iron (or DRI) industry and in the production of methanol.

The sponge iron industry

In the sponge iron industry, natural gas is used as a primary agent for the reduction of iron oxides into metallic iron, either in the form of Hot Briquetted Iron or iron carbide, for subsequent use in the manufacture of steel slabs and billets. DRI is a substitute for the use of scrap as a feedstock in arc and blast furnaces. The Midrex process is used in India by both Essar and Vikram Ispat at Hazira and Raigarh respectively, whilst the HYL III process is used by Grasim, also at Raigarh.

The production of methanol

Natural gas is the dominant feedstock for production of methanol through the partial oxidation process. Methanol is one of the major basic chemical raw materials. At present methanol production in India from gas is limited to a single plant in Gujarat operated by Gujarat Narmada Fertilizer Company.

The glass and ceramics industry

Gas is used in the glass and ceramics industry to fire furnaces in which the raw materials, fluxes and oxidising agents are mixed. The demand from the glass industry is relatively low – a typical glass plant would consume no more than 0.1 MMCMD. The glass industry will be a willing consumer of gas but will not be able to provide an anchor load.

Other areas of gas use

Gas is also used in industries for process heating and steam-raising. Oil refineries use some gas to produce H_2 for de-sulphurisation and hydro-cracking.

The domestic sector

For domestic consumers, the main use of gas will be in replacing kerosene and LPG for cooking. Domestic consumers have to piggyback on large consumers as the city distribution projects would not be viable otherwise.

Expected trends in gas demand

The demand for gas up to 2025, the indigenous supply and the deficit have been examined in the Hydrocarbon Vision 2025 brought out recently by the Government of India. The requirement of gas over this time horizon would depend upon a number of factors and their complex inter-relationship. The growth in energy consumption would depend upon the growth of population and of GDP, the structural changes in GDP, the growth of industrial and agricultural sectors, energy pricing and tariffs and the success of energy conservation measures based on the need to contain damage to the environment.

According to the Vision document, the power and the fertiliser sectors would dominate gas consumption and the demand would build up as shown below.

Table 1.5 Total gas demand (MMCMD)

	1998/99	2001/02	2006/07	2011/12	2024/25
Power					
Scenario 1*	22	40	67	90	153
Scenario 2**	22	67	119	168	208
Fertilizer	24	54	66	83	105
Others#					
Scenario 1	9	23	33	43	64
Scenario 2	9	30	46	63	78
Total					
Scenario 1	55	117	166	216	322
Scenario 2	55	151	231	313	391

* gas at $4/MMBtu

** gas at $3/MMBtu

other sectors account for 20% of total demand in 2002 and thereafter

Source. Hydrocarbon Vision 2025, GOI

Future gas production projections

ONGC draws up long term profiles of gas production every year. These are based on development plans already finalized as well as in anticipation of future discoveries. Current projections show that the total gas production would decline steadily until the Bombay High gas cap is brought into production. This is expected between the years 2015 and 2020.

Demand - supply balance

The declining production profile coupled with the projection of rising demand shows a widening demand-supply gap. This implies that exploration efforts need to be stepped up and the feasibility of importing gas from the neighbouring countries examined seriously. The initiatives and prospects for exploration have been described earlier. The options for importing gas through pipelines and as LNG are outlined below.

Pipeline gas import projects

Oman - India deep water pipeline

An in-principle agreement was signed by the governments of India and Oman in September 1994 for the import of 56.6 MMCMD of gas through two sub-sea pipelines. The gas from the first pipeline was to be utilized in western and northern India and the second was planned to be taken to south India. In order to avoid the territorial waters and the Exclusive Economic Zone (EEZ) of Pakistan, a deep-sea route was proposed. Parts of the route lay at water depths exceeding 3000 metres. The Oman Oil Company could not develop the necessary technology to lay pipelines at that depth. Also, the proven gas reserves in Oman did not support both the pipeline and the LNG Projects. As a result, the pipeline proposal has not been seriously pursued after 1997.

Iran - Pakistan – India

India and Iran signed a MoU in 1993 to study the feasibility of importing 50-75 MMCMD of gas through a pipeline landing in Kachchh in India. A shallow offshore route through the EEZ of Pakistan was proposed. A feasibility study was awarded to PLE of Germany. However, work on the feasibility study could not be started as the government of Pakistan did not permit the route survey. An onland alternative through Pakistan has also been under consideration. Pakistan had favoured this option but the Indian side has worried about the security of supplies. Progress on the project will be possible only when the relations between India and Pakistan improve.

Bangladesh - India pipeline

Unocal and Shell have led the efforts being made to import gas from Bangladesh to India. Unocal has proposed pipelines from the Bibiyana fields in Bangladesh whereas Shell has proposed bringing gas from the Sangu fields in offshore Bangladesh. Some of the proposals involve small quantities to be brought to Bengal but others envisage at least 1 bcfd to be fed into the HBJ for consumers in western India. Bangladesh has so far not agreed to export proposals on the ground that the gas is required for consumption within Bangladesh. A decision could be expected after the elections due in the next three months.

Myanmar - Bangladesh - India

GAIL has an MOU with Cairns Energy / Shell and Halliburton for the study of a 1 bcfd pipeline from Myanmar via Bangladesh. The proposed pipeline alignment covers Orissa, Andhra Pradesh, the eastern portion of Karnataka and Tamil Nadu. Myanmar is yet to prove sufficient gas reserves to support such a project.

Turkmenistan - Afghanistan - Pakistan - India

This proposal was pursued by Unocal of USA under the Centgas consortium, for bringing gas from Turkmenistan's Dauletabad fields to markets in northern Pakistan, with the potential of an extension from Multan to New Delhi, India. They have since withdrawn from the venture on account of the situation in Afghanistan.

Qatar - India

A proposal for bringing gas by pipeline from Qatar through Pakistan has been promoted by Crescent Company of Sharjah but little progress has been made.

The projects listed above are considered economically viable. The problems are political in nature and an early solution of the problems is unlikely.

Import of LNG

Proposed LNG terminals in India

As the pipeline proposals got into one trouble or the other, proposals for importing LNG gained ground. The proposals now being pursued are shown in Map 1.2.

Petronet LNG has signed an agreement with Rasgas of Qatar for the LNG supply. The EPC contract for the Dahej terminal has been awarded. LNG supply is expected in 2005. The gas is proposed to be fed into the HBJ pipeline. The marketing of the gas will be done mostly by GAIL and also by BPCL. Gas sales contracts with gas consumers are being negotiated but are yet to be signed. Shell is proceeding with the Hazira terminal but no date for commissioning of the receiving terminal has been announced. Shell's main advantage is that supplies can be sourced from any of its LNG facilities in the region. The BG proposal of LNG at Pipavav is yet to make any progress.

In Maharashtra, the Dabhol LNG terminal is in trouble as the fate of the Dabhol power plant hangs in the balance. The proposed terminal at Trombay is under review by the promoters. The Kochi project of Petronet LNG is delayed, as firm customers of gas have not been identified. The Ennore project in Tamil Nadu is tied to a 1800 MW power plant. Tamil Nadu is able to buy 800 MW. The Power Trading Corporation is negotiating power purchase agreements with the southern states and the project can go ahead only after these are agreed upon. The Kakinada proposal of IOC, BP, etc. is at an early stage. Announcement recently made about gas discoveries in the area may delay this project.

mestic gas price

The price of gas sold by ONGC and GAIL, price of gas from fields operated by joint ventures and also transportation charges along the HBJ are fixed by the Government. Gas from private fields are sold at negotiated prices.

The price of natural gas has been fixed by the Government since 1987. In 1987, the price was \$ 0.86/MMBtu (\$1= Rs 46) for gas at landfall points and a flat \$ 1.38/MMBtu for gas along the HBJ line. The gas price was much lower than the prices of alternative fuels and the government felt the need to bring the price to the consumer in line with these prices.

The Kelkar committee was appointed in 1990 to recommend revisions in the gas prices. The committee recommended that the price payable to the producers be fixed on the basis of the long run marginal cost of production estimated at \$0.92/MMBtu. The consumer price was to be increased annually to reach \$1.13/Mmbtu, which was near enough to the prevailing fuel oil price. The difference between the consumer price and the producer price was credited to the Gas Pool Account – an account set up to compensate ONGC and OIL for the concessional price of gas in the North-East.

In 1996 the Sankar Committee was established to review the above rates, with some consideration given to the impending need for gas imports and the effects of import parity pricing. The committee decided that import parity pricing would be too steep a transition. The committee left intact the principles of fixing the producer price and the consumer price earlier recommended by Kelkar. The prices were however revised upward based on fresh estimation of the costs.

Having considered these recommendations, in October 1997 the government instituted a new series of gas prices, valid through to March 31, 2000. The consumer price of gas at landfall points were linked to the price of a basket of fuel oils as shown in the table below.

Table 1.6 Natural gas pricing against a basket of fuel oils (%)

	Percentage of LSHS/FO price	
Year	General price	Concessional price for the NE states
1997-98	55	35
1998-99	65	40
1999-2000	75	45

The price is determined and notified by GAIL with the approval for the Ministry for every quarter depending upon the average price of the following basket of fuel oils (with equal weights to each type) based on the figures obtained from Platt's Oilgram for the previous quarter.

- Cargoes FOB, Med Basis, Italy (1% Sulphur)
- Cargoes CIF NEW Basis, ARA (1% Sulphur)
- Singapore, FOB, HSFO 180 cst (3.9% Sulphur)
- Arabian Gulf, FOB, HSFO 180 cst (3.9% Sulphur)

The price varies between the floor of \$ 1.32/MMBtu and the ceiling of \$ 1.76/MMBtu. This consumer price of gas is linked to a calorific value of 10000 kcal/m^3. The price has now reached the ceiling and is being reviewed with a view to introducing 100% fuel oil parity prices.

ONGC/OIL/GAIL and joint venture operations are permitted to sell gas from marginal isolated fields to be developed in future, at market driven prices.

The transportation charge along the HBJ pipeline has increased since 1997 by 1% for every 10% increase in the consumer price index. This increase is paid to GAIL out of the Gas Pool Account. The transportation charge has been linked to the calorific value of 8500 Kcal/m^3. Out of the consumer prices collected by GAIL, GAIL retains the amount required to pay for the higher cost of gas purchased from the joint venture companies who are paid full fuel oil parity prices.

The above prices are applicable to gas sold by ONGC or OIL to GAIL and to sales by GAIL to consumers. Sales by private field operators are linked to fuel oil prices. The prices applicable at different interfaces are as shown below.

Gas sales by ONGC/OIL to GAIL

As detailed above.

Gas sales by private upstream companies

To GAIL

These are negotiated between the government and the private operators and included in the production sharing contracts. So far these prices have been full fuel oil parity prices but the fuel oils basket could differ from one case to another.

Direct to end-users

These are freely negotiated and are mostly linked to prices of alternative fuels. Transportation charges are also negotiated.

Gas sales by GAIL to end-users

As detailed above. The transportation charge on the HBJ pipeline provides GAIL a 12% post-tax return on net worth. The transportation charges on other pipelines is fixed by GAIL on the same principle.

Gas sales by GAIL to distribution companies

The distribution companies pay the same price to GAIL as any other customer.

Gas sales by distribution companies to end-users

These are negotiated prices linked to alternative fuels.

Taxes and duties

In addition to the price as fixed above, royalty, taxes, duties and other statutory levies on the production and sale of natural gas is payable by the consumer. The royalty on gas as fixed under the Oilfields Development Act is 10% of the wellhead price. For gas sold by ONGC, this is now $0.18/mmbtu, one-tenth of the ceiling price of $1.80/mmbtu. For privately operated fields, the royalty is fixed on the negotiated wellhead prices. There is no cess on natural gas (unlike crude oil) although a cess could be levied under the law. There is no excise duty as natural gas or on crude oil as these are minerals although excise duty is charged on petroleum products. A sales tax is leviable at state rates if the sale is within the state or at the central rate of 4% for inter-state sales. The state sales tax rates vary from one state to another, ranging from zero to 22%.

A typical price build up for gas produced in a state and sold within the state would be as below.

	$ / mmbtu
Gas price	1.80
Royalty	0.18
Transportation charge	0.43
Sales tax (20%)	0.48
Total	2.89

It is to be noted that GAIL does not make a margin on merchant sales; it is allowed a return only on its investment in the pipeline.

In addition to this, there would be a customs duty to be paid on imported gas/LNG. This duty is now 5%. A countervailing duty of 16% was levied till last year on LNG except when used for power generation. This has now been removed so that the duty is now the same for all consumers. The gas industry has been asking for 'infrastructure' status, with a consequent reduction in the customs duty to be paid on components imported for pipelines and LNG receiving terminals. The concession, if granted, could make a difference of around 7-8 cents/mmbtu in the regasification cost. However, there is no guarantee that the benefit would be passed on to the consumer. The government has not yet agreed and is not likely to agree.

Contractual arrangements for sale of gas

There is no contract as yet between ONGC and GAIL regarding gas supplied by the former to the latter. This has not given rise to major problems as both are public sector undertakings. For supplies to its consumers, GAIL has evolved a standard contract to which case-specific small variations can be made. The major points covered in such contracts are:

- *Period of contract*: The period is between 10 and 15 years from the date of commencement of supply.
- *Activity milestones for new customers*: The contract spells out the dates of completion of major activities for new plants like purchase of land, ordering of equipment, commencement of construction, completion of construction, etc. The contract requires all purchasers to lodge with GAIL a refundable cash deposit and a bank guarantee (equivalent to about three times the cash deposit). GAIL is required to pay interest on the cash deposit. The contract also stipulates that GAIL has the right to forfeit 25% of the bank guarantee for delay in completion of any of the stipulated major activities in a new plant beyond three months of the milestone schedule. The right of GAIL to

cancel the contract for further delays in construction activities is also incorporated in the contract.

- *Manner of delivery of gas*: The inlet pressures, location of the Gas Metering Station, its installation and maintenance by the seller at the consumer's cost and provision of a check metering station by the consumer, are provided in the contract. Besides, frequency and method of calibration of metering unit are specified.
- *Quantity of gas*: The progressive schedule of delivery is indicated in the contract in terms of daily quantity. However, prior to each contract year the customer is required to indicate a forecast of gas requirement. The customer guarantees a minimum off-take of around 80% of the contracted quantity and payments being made up to this 80% level even when the off-takes are lower (take or pay).
- *Specification of gas*: The quality of gas to be supplied and the method to be followed for gas sampling is annotated. Typical limits of composition of the gas at the delivery point are indicated.
- *Price of gas*: This is as decided by the GOI in its price notification that is issued periodically. In addition transportation charges, royalty, taxes, duties and other statutory levies of the Central/State Government or any other local bodies are borne by the buyer.
- *Transport cost*: This is either a fixed amount as for delivery ex-HBJ pipeline or according to a formula, where a new gas line is laid for making supplies of gas available to a consumer. In respect of existing customers outside the HBJ pipeline, the transport charges as earlier agreed mutually between the supplier and consumer will continue. However, for future the new formula will be relevant. This formula covers annual depreciation of pipeline cost, reasonable return on capital cost of the pipeline and its operation and maintenance costs. The transport cost is subject to escalation at 3% per annum.
- *Billing and payment terms*: Invoices are submitted fortnightly and customers are to pay within 3 working days of presentation of an invoice. The customer has to open and maintain an irrevocable Letter of Credit with a bank notified by the seller, covering a value of fifteen days supply of gas at maximum contracted quantity and the monthly transportation charge. If, for any reason, payment is delayed or any disallowance made from the invoice, the seller may present the invoice for the full amount or for the amount not paid, as the case may be, to the bank against the Letter of Credit and draw

the amount. For supplies to continue, the customer has to reinstate the full amount of L/C.

- *Arbitration*: This is generally guided by the provisions of Indian Arbitration Act. Besides, other Indian Laws relating to contract, etc. are fully applicable.

GAIL's contracts with consumers have been criticised as being one-sided. While GAIL is protected by take-or-pay provisions, there is no penalty on GAIL for short-supply.

Issues in gas contracts

Some of the important points in respect of these contracts between different parties are listed below. First, different prices prevail at different locations depending on the transportation cost and sales tax, but no distinction is made currently between different categories of consumers in the same location with reference to the opportunity value of gas they use. Secondly, supplies of gas to all categories are non-interruptible, except for those delivered to "fall-back" customers. Currently to avoid under-utilisation of available gas, allocations are made in excess of the availability. This requires rationing of gas and the use of alternative fuels. While dual-fuel arrangements were earlier made only as exceptions, the Government now insists on dual-fuel arrangements for all customers. Thirdly, GAIL today discharges the role of both a transporter and a merchant. In the few cases where ONGC and OIL sell gas direct to consumers, they also provide 'bundled' services.

Pricing of gas from LNG

The long run marginal cost of producing gas by ONGC has been estimated at $1.1/mmbtu. The cost of production from medium sized fields operated by OIL or private operators would be slightly higher. The cost of gas likely to be found in the NELP blocks would vary, depending on the size of the gas discoveries. Andhra Pradesh is the only place where large discoveries are expected and gas-to-gas competition may drive the gas price down. Elsewhere, gas should be saleable at replacement prices of alternative fuels. For the power sector, the alternative fuel is coal, domestic or imported. In the production of urea, the competition is with imported urea. In industries, the alternatives are coal, fuel oil and LPG. The replacement prices or imputed values are computed for different consumers at various locations elsewhere in this report. The imputed values will be the highest for power, urea and the glass and ceramic units as also for the domestic sector where gas will replace LPG.

At present, GAIL is selling gas at fuel oil linked prices. These prices would soon rise to full fuel oil parity. A proposal to this effect is pending for approval. With the present high prices of fuel oil, the gas price which is now capped at $1.76/mmbtu would jump to around $3.6/mmbtu. The price along the HBJ would then be $4.28/mmbtu. The consumers are resisting this steep increase. The steel industry, an important gas consumer now reeling under recession will be hit badly. The finance ministry is unhappy because the fertiliser subsidy will go up sharply.

Even after the price revision goes through, the price to many consumers would be below the imputed value. In the case of LNG it is clear that the price to the consumer would be the replacement value as otherwise LNG would not be saleable. The same would be true of gas found in NELP blocks or CBM blocks and sold through negotiations. The question remains if GAIL would be allowed at that time to charge market prices in respect of domestic gas also? This is quite likely. As seen above, the gas price would be fairly close to the import parity level once the price cap is removed. Besides, it would be difficult to have different prices for the same fuel, especially as they would be physically mixed up in most cases.

A number of naphtha based power plants were commissioned in the country over the last two years. All of these ran into trouble on account of soaring naphtha prices, including the Enron project in Maharashtra, which received a lot of publicity. Many of these units were restricted to the minimum guaranteed offtake of power. This experience has important implications for LNG. The electricity regulator who has to approve the procurement of power by utilities would approve an LNG based power plant only if satisfied that it would cost less than others. Such comparisons would assume a price band for crude oil, something like $20-25/bbl. Although there are many locations where LNG would be a competitive option at these prices, the project may not be able to deliver power if crude oil prices go up to $30/bbl or more. The regulators would probably require price ceilings while approving LNG based projects. This would be true of fluctuations in the rupee-dollar parity also. Accordingly, the dollar denominated portion of the gas price would need to be kept at the minimum possible level.

Pricing of alternative fuels

The price of coal was decontrolled with effect from 1st January 2000. Coal is graded according to quality and different grades are priced differently. In Chapter9, the delivered prices of coal have been worked out for various locations. These are based on present prices and present railway freights. No indications are now available as to how these will move in future. Railway freights would normally move up unless it were decided to phase out the cross-subsidy in freights. In that case some reduction would also be possible.

The price of naphtha was decontrolled in 1997 and it is now priced at import parity. The import of naphtha for urea production is duty free but other consumers have to pay a customs duty of 10%. With naphtha availability projected to be in surplus, an export parity price is also possible. These prices have been computed in Chapter9. The price of LPG when used as a domestic fu is still administered along with those of kerosene and gasoline. These prices are scheduled to be decontrolled in April 2002. The price of LPG used by the industry has been fixed on an import parity basis since 1997.

2

Brief profiles of the states

Gujarat

Map 2.1 shows the location of the state.

Ahmedabad is the state capital. Vadodara is the industrial center. Gujarat has the longest coastline, stretching over 1600 km. It has the major ports of Kandla and Vadinar under the administrative control of the Central Government and 40 minor and intermediate ports under the jurisdiction of the State Government. Kandla handled the largest amount of traffic of 46.3 million tonnes in 1999/00. Crude oil and petroleum products form about 43% of the total traffic handled at major ports in India. Kandla alone handled the largest chunk of 30% of the oil products in 1999/00.

The economy

The Gross State Domestic Product (GSDP) at constant (1993/94) prices, increased from Rs. 50069 crores in 1993/94 to Rs. 74911 crores in 1998/99 indicating a compound annual growth rate of 8%. The corresponding figure for India was 6.7%. Sectoral contributions to GSDP in 1998/99 are illustrated in Figure 2.1.

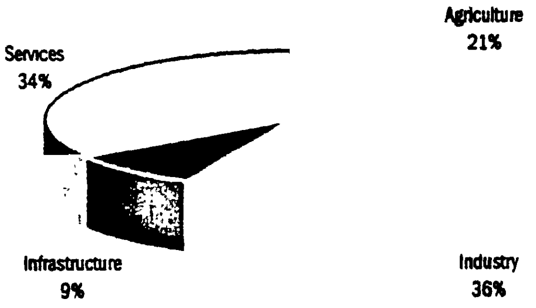

Figure 2.1 Sectoral contributions to GSDP in 1998/99

Industrial and services sectors score over the agricultural sector in terms of contribution to GSDP. Agriculture in Gujarat is highly dependent on groundwater extraction, as there are no major rivers in the state. This calls for a large consumption of electricity.

According to the provisional results of Census of India 2001, Gujarat currently has a population of 50,596,992. Population in the state has grown at an annual compound rate of 2.03% compared to the national average of 1.93% from 1991 to 2001. However, the population density is 258 per sq. km compared to the national average of 324 per sq. km. The literacy rate in Gujarat is 69.97%, above the all India average of 65.38%.

The energy sector

Coal reserves

Gujarat has small lignite fields in Kachchh in the western part of the state and Rajpardi, Vastan and Ghoga fields in the districts of Bharuch, Surat and Bhavnagar districts. The Kachchh lignite mines, operated by the Gujarat Mineral Development Corporation supplies lignite to the pit-head Kachchh Lignite Thermal Power Station. Another lignite-based power plant is coming up at Akrimota in the same region. A lignite-based power plant is also working in Surat and more are expected.

The power sector

In the total installed capacity of 8761 MW in the state, the state has a share of 52%, the private sector 30% and centre 18%. Among fuels, coal has the largest share of about 65% followed by gas at 24%. Coal is mainly sourced from Madhya Pradesh. The fuelwise installed capacity is illustrated in the Figure 2.2.

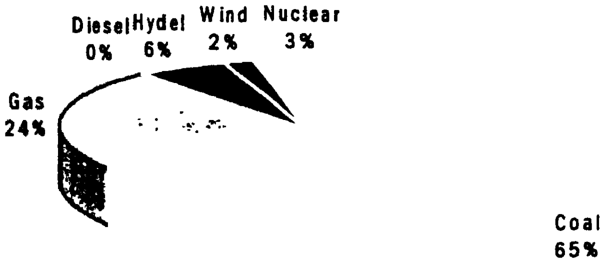

Figure 2.2 Fuelwise installed capacity in Gujarat (as of May 2001)
Source. CEA

Power generation in the state is the responsibility of the Gujarat Electricity Board (GEB) under the state government. The Gujarat State Electricity

Corporation Limited has been incorporated by GEB and Gujarat state government having a stake of 50% each, with the objective of taking on future generation projects of the GEB. The Gujarat Industrial Power Corporation Limited is another power producer in the joint sector. In the private sector, Ahmedabad Electricity Company (AEC) generates power for Ahmedabad and nearby regions, the Essar Power Limited and Gujarat Torrent Energy Corporation supplies power to GEB. Central sector projects of Tarapur Atomic Power Station (Maharashtra), Kakrapar Atomic Power Station (Gujarat) and NTPC plants at Kawas, Gandhar, Korba and Vindhyachal also supplies power to Gujarat.

GEB is solely responsible for planning and implementation of the transmission network within the state. The Power Grid Corporation is responsible for the state grids link to the regional grid and for inter-regional power transmission. In case of distribution, along with GEB, there are two private sector licensees – AEC and Surat Electricity Company (SEC).

Oil and natural gas

The Western Onshore Business Unit (WOBU) of ONGC operates oil and gas fields in the Ankleshwar, Ahmedabad, Mehsana, Cambay and Gandhar areas of Gujarat. This is the largest onland oil producing region of ONGC. Oil production from Gujarat onshore over the past decade is illustrated in the Figure 2.3.

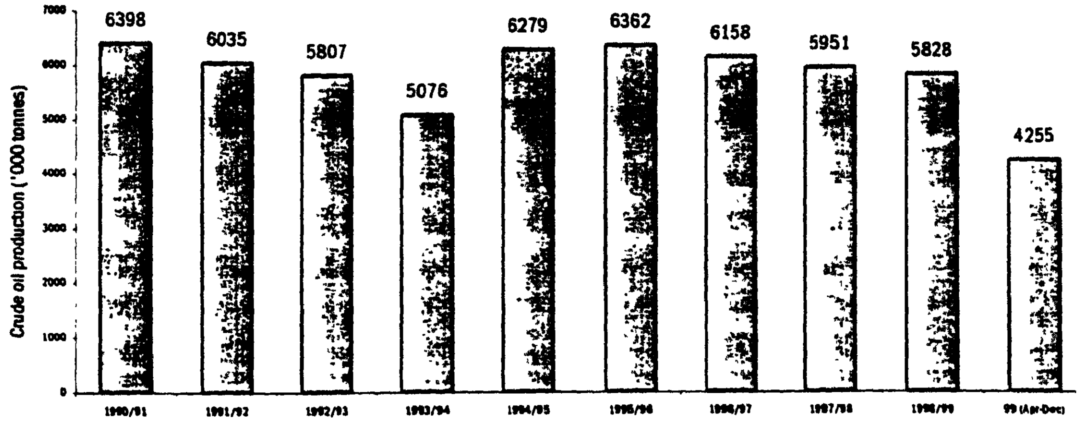

Figure 2.3 Crude oil production in Gujarat onshore ('000 tonnes)
Source. Ministry of Petroleum and Natural Gas

The trend in natural gas production in Gujarat over the past decade is in the Figure 2.4.

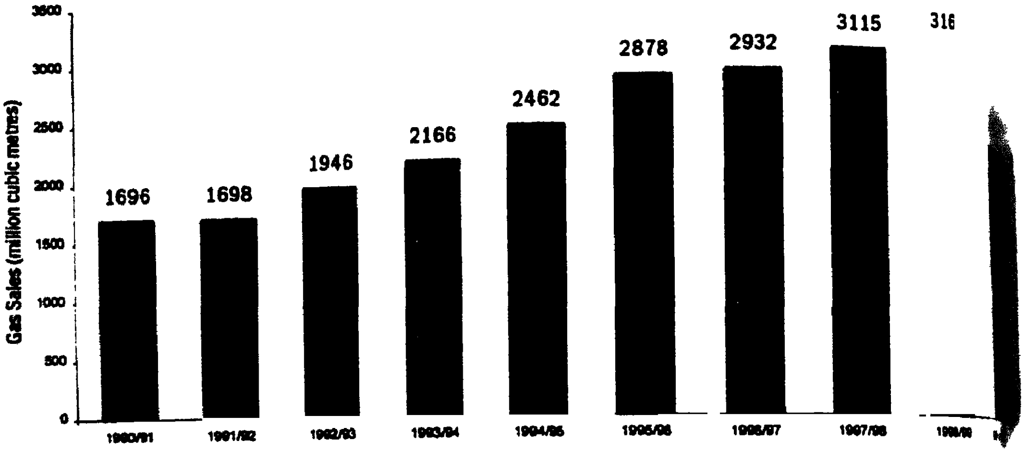

Figure 2.4 Natural gas production in Gujarat onshore (million cubic metres)
Source. Ministry of Petroleum and Natural Gas

Four LNG terminals are planned in the state of Gujarat alone at Jamnagar, Pipavav, Dahej and Hazira.

Domestic oil and gas production is expected to increase with onshore and offshore blocks being offered under the New Exploration Licensing Policy (NELP). Under the first round of NELP, Niko Resources Limited was awarded two shallow water offshore blocks in Gujarat off Kachchh and Saurashtra. In the second round of NELP bids have been invited for 5 blocks in the Gujarat region, 2 deep-water blocks, 1 shallow offshore block and 2 onland blocks.

Madhya Pradesh

Map 2.2 shows the location of the state. Recently, the eastern part of the state was included in the new state of Chattisgarh. Erstwhile Madhya Pradesh was the largest state in India and stretched over 4,43,446 sq kms. The loss of the eastern part means the loss of rich mineral resources including coal.

The economy

The Gross State Domestic Product (GSDP) at constant (1993/94) prices, increased from Rs. 52,752 crores in 1993/94 to Rs. 65,520 crores in 1998/99 indicating a low compound annual growth rate of about 4%. Sectoral contributions to GSDP in 1998/99 are illustrated in Figure 2.5.

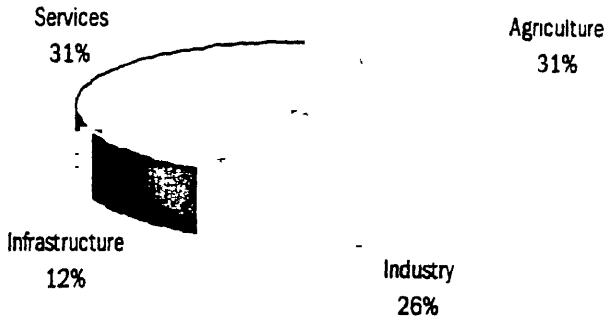

Figure 2.5 Sectoral contributions to GSDP in 1998/99

Madhya Pradesh has a population of 8,11,81,074. The population density is 183 per sq. km much below the national average of 324 per sq. km. The state has a literacy rate of about 64%.

The energy sector

Coal reserves

Singrauli, Sohagpur, Korba and Pench-Kanhan are major coalfields in this region now falling in Chhattisgarh. The fields are operated by the Northern Coalfields Limited, South-Eastern Coalfields Limited and Western Coalfields Limited, all subsidiaries of the Coal India Limited. Apart from catering to indigenous power plants, coal from Madhya Pradesh is transported to power-houses in Rajasthan, Gujarat and Maharashtra.

The power sector

In the total installed capacity of 5,991 MW in Madhya Pradesh, the state has a share of 73% and the centre about 27%, the private sector has only 22 MW. Coal has the largest share of 79% in total installed capacity and Madhya Pradesh was self sufficient in coal for power generation. The fuelwise installed capacity is in the Figure 2.6.

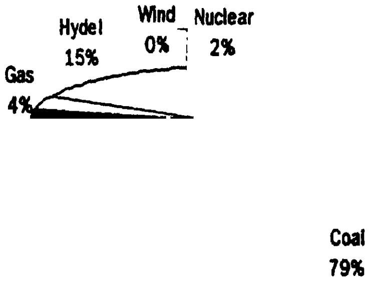

Figure 2.6 Fuelwise installed capacity in Madhya Pradesh (as of May 2001)

Uttar Pradesh

The state of Uttar Pradesh shares a common international boundary with Nep and China on the northern side. In 2001, Uttaranchal was carved out of the northern part of Uttar Pradesh. Uttar Pradesh[a] is crossed by major rivers like the Ganges and Yamuna making the state agriculturally fertile. The major crops are sugarcane and wheat. A map showing the location of the state is at Map 2.3.

The economy

The Gross State Domestic Product (GSDP) at constant (1993/94) prices increased from Rs. 87,555 crores in 1993/94 to Rs. 1,14,025 crores in 1998/99 indicating a compound annual growth rate of 5%. Sectoral contributions to GSDP in 1998/99 are illustrated in Figure 2.7.

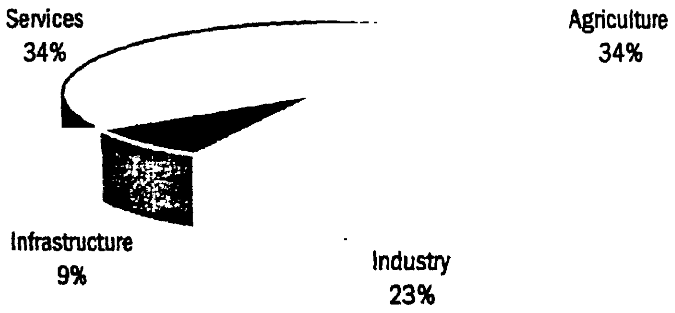

Figure 2.7 Sectoral contributions to GSDP in 1998/99

Among all states, Uttar Pradesh, in absolute terms, has the largest area under wheat and sugarcane, has the highest production of wheat and sugarcane and records the largest consumption of urea. UP accounted for 24% of urea consumption in India in 1998/99.

Uttar Pradesh has the largest population 17,45,32,421, which is about 17% of all India population. The population density is 689 per sq. km about double the national average of 324 per sq. km. UP has a literacy rate of 65.74%. Uttaranchal region has a higher literacy rate of 72.28% compared to 57.36% in the new state of Uttar Pradesh.

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[a] For this study Uttar Pradesh indicates the erstwhile state, including Uttaranchal, unless otherwise mentioned.

The energy sector

The power sector

In the total installed capacity of 8,424 MW in Uttar Pradesh, the state has a share of 67% and centre 33%. 73% of the installed capacity is coal based. The fuelwise installed capacity is illustrated in Figure 2.8 below.

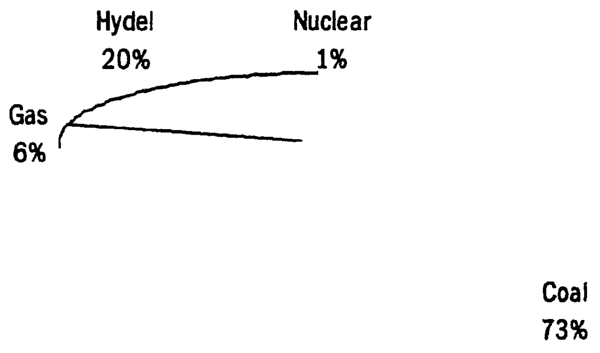

Figure 2.8 Fuelwise installed capacity in Gujarat (as of May 2001)

Gas utilization

Uttar Pradesh is on the HBJ network. TCL Babrala, Indo Gulf Jagdishpur, Oswal Shahjahanpur and IFFCO Aonla are prominent gas consuming fertiliser plants and have an allocation of 1.76 MMCMD each. The NTPC power plants at Dadri and Auraiya are running on gas and together have an allocation of 5.12 MMCMD. Apart from these, the Ghaziabad and Noida industrial estates near Delhi has a number of units using gas. Recently, Indraprastha Gas has announced that it will take up city gas projects in Bareilly and Lucknow.

Punjab

The neighbouring states of Punjab and Haryana have a common capital – Chandigarh, which is a union territory. Punjab stretches over 50,362 sq kms and is an agriculturally fertile state. Map 2.4 shows the location of the state.

The economy

The Gross State Domestic Product growth rate, at constant (1993/94) prices, from 1993/94 to 1998/99 averaged around 4% for Punjab. The GSDP increased from 30,249 crores in 1993/94 to 37,154 crores in 1998/99. Sectoral contributions to GSDP are illustrated in the Figure 2.9.

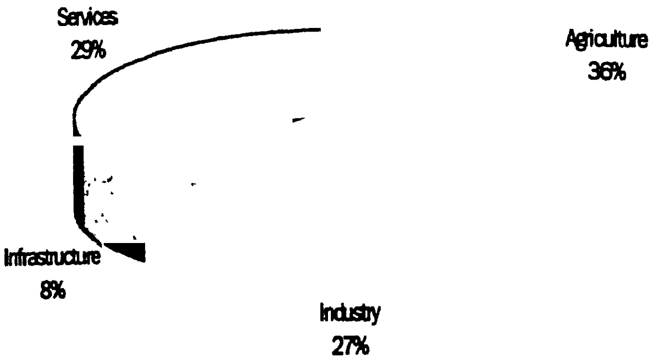

Figure 2.9 Sectoral contributions to GSDP in 1998/99

Wheat is the main crop in the state and Punjab has the highest yield of wheat. Punjab has the second highest intensity of fertilizer consumption per hectare, after Delhi.

Punjab has a population of 2,42,89,296, which is 2.37% the total population of India. The population density is 482 per sq km. Over the past decade population in Punjab has grown at annual rate of 1.80%. Literacy rate in Punjab is 69.95%.

The energy sector

Energy resources are lacking in these states with the absence of coal, oil or gas reserves. However Punjab is rich in water resources.

The power sector

Punjab has a total installed capacity of 5744 MW, in which the share of state is 79% and that of the central sector is 21%. Private sector has no share in installed capacity. Fuelwise installed capacity in the state is illustrated in the Figure 2.10.

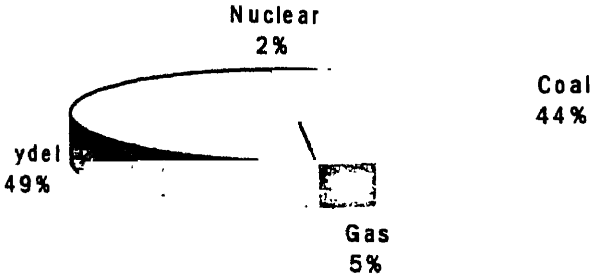

Figure 2.10 Fuelwise installed capacity in Punjab (as of May 2001)

Share of hydel in installed capacity is large due to the presence of several rivers crossing the state. Punjab has five major rivers – Ravi, Beas, Sutlej, Jhelum and Chenab running through it. The Bhakra-Nangal project spread over Punjab, Haryana and Himachal Pradesh is one of India's major irrigation and power projects.

Haryana

Haryana is adjacent to Punjab and stretches over 44,212 sq kms. Map 2.5 shows the location of the state.

The economy

The Gross State Domestic Product growth rate, at constant (1993/94) prices, from 1993/94 to 1998/99 averaged around 6% for Haryana. Sectoral contributions to GSDP in the Haryana in 1998/99 are illustrated in the Figure 2.11.

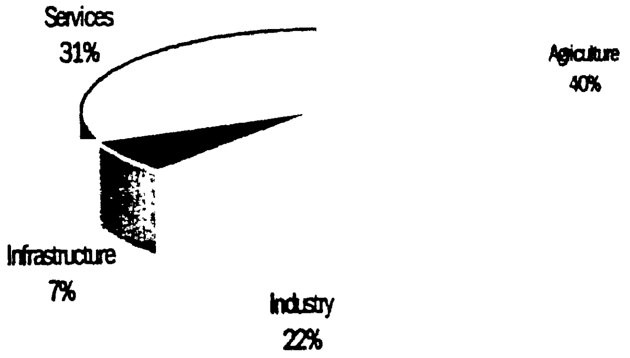

Figure 2.11 Sectoral contributions to GSDP in 1998/99

Haryana is agriculturally fertile, the main crop being wheat. Haryana has the second highest yield of wheat, after Punjab.

Haryana has a population of 2,10,82,989, which is 2.05% of the total population of India. The population density is 477 per sq km. Over the past decade population in Haryana has grown at annual rate of 2.47%. Literacy rate stands at 68.59%.

The energy sector

The power sector

Haryana has an installed capacity of 3,280 MW of which state has a share of 61% and centre 39%. Private sector has no share in installed capacity. Fuelwise installed capacity in the state is illustrated in Figure 2.12 below.

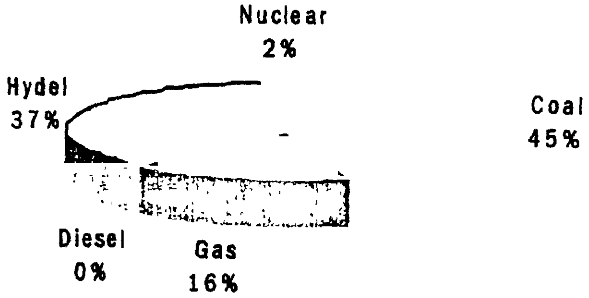

Figure 2.12 Fuelwise installed capacity in Punjab and Haryana (as of May 2001)

Delhi

A map showing the location of the state is at Map 2.6.

The economy

The Gross State Domestic Product (GSDP), at constant (1993/94) prices increased from 19,665 crores in 1993/94 to 31,099 crores in 1998/99 indicating a compound annual growth rate of 10%much above the India average of 6.7%. Sectoral contributions to GSDP in 1998/99 are illustrated in the Figure 2.13.

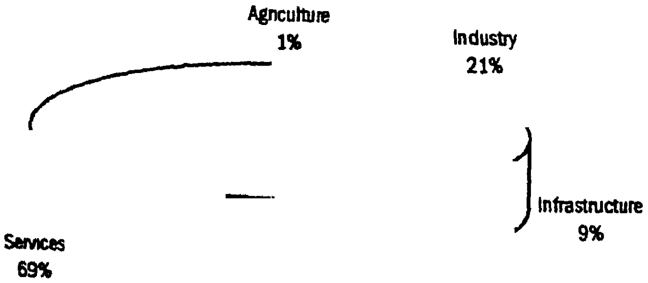

Figure 2.13 Sectoral contributions to GSDP in 1998/99

Contributions from the services sector forms the bulk of GSDP.

Delhi at present has a population of 1,37,82,976 which makes it the state with the highest population density of 9,294 per sq km. Population in the state has grown at a high annual compound rate of 3.81% (second highest among all states) compared to India average of 1.93% from 1991 to 2001. As expected, Delhi has a high literacy rate of 81.82%, which is much above the national average of 65.38%.

Recently, the Delhi Government has taken measures to arrest the deteriorating environmental standards in the state. According to the Supreme Court directive (dated July 28, 1998) all autos and taxis are to run on CNG and the entire city bus fleet is to be converted to CNG by September 2001. Indraprastha Gas Limited (IGL), a subsidiary of GAIL was incorporated in December 1998 for supplying gas to Delhi. CNG is distributed at 68 stations in Delhi and the present allocation of gas to the city is 0.48 MMCMD.

energy sector

The power sector

In total installed capacity of 2,925 MW, the state owned Delhi Vidyut Board (DVB) has a share of 21% and central sector 79%. Fuelwise installed capacity has been illustrated in Figure 2.14.

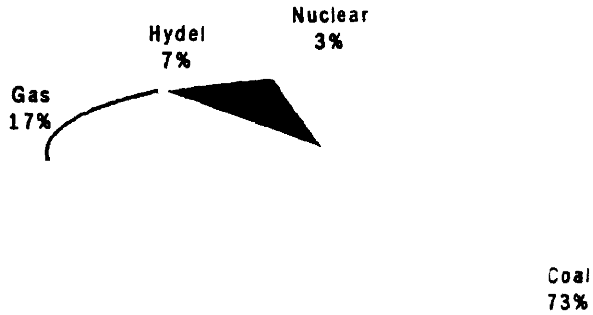

Figure 2.14 Fuelwise installed capacity in Delhi (as of May 2001)

There are two state owned power plants, the Delhi TPS running on coal and Delhi CCGT running on gas fed from the HBJ.

Gas utilization

Delhi is connected to the HBJ pipeline. Gas allocations to various sectors is listed in Table 2.1. Detailed allocations to Delhi industries has been shown at Annexure 2.1.

Table 2.1 Gas allocation to various sectors in Delhi

Sector	Allocation (MMCMD)
Delhi industries	0.5
Delhi CNG	0.48
Power	2.54
Total	3.52

Source. GAIL

Rajasthan

The location of the state is shown in Map 2.7. The Thar desert takes up the western part of the state.

The economy

The Gross State Domestic Product (GSDP) at constant (1993/94) prices, increased from Rs. 33,025 crores in 1993/94 to Rs. 45,704 crores in 1998/99 indicating a compound annual growth rate of 7%. Sectoral contributions to GSDP in 1998/99 are illustrated in Figure 2.15.

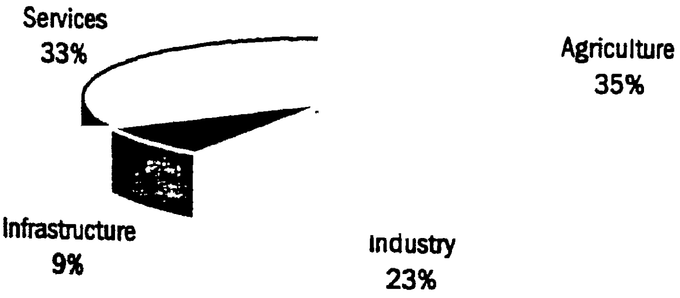

Figure 2.15 Sectoral contributions to GSDP in 1998/99

Population in the state has grown at an annual compound rate of 2.49% from 1991 to 2001 and currently stands at 56,473,122. Rajasthan has a low population density of 165 per sq. km compared to the national average of 324. It has one of the lowest literacy rates in the country of only 61.03%.

The energy sector

Lignite reserves

Rajasthan has lignite mines in the districts of Barmer, Bikaner and Nagaur. Palana and Barsinghsar are important fields in the Bikaner region. Lignite based power plants are expected in Kapurdi and Jalipa in the Barmer district.

The power sector

In the total installed capacity of 4434 MW, the state has a share of 56% and centre about 44% with only a minute share of the private sector. Coal has the largest share of about 43% in total installed capacity followed by hydel at 24%. The fuelwise installed capacity is illustrated in the Figure 2.16.

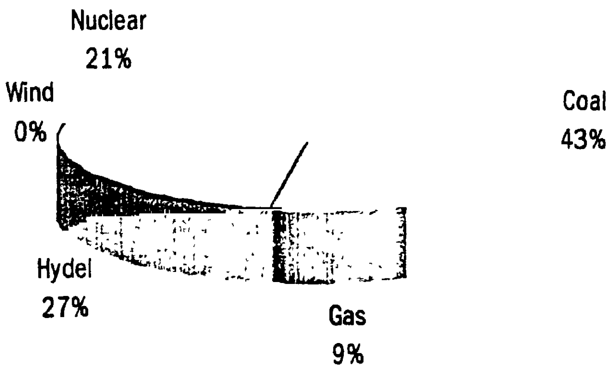

Figure 2.16 Fuelwise installed capacity in Rajasthan (as of May 2001)

Gas utilization

The NTPC power plant in Anta and the urea plant of the Chambal Fertilizers and Chemicals Limited at Gadepan are using gas from the HBJ. They have allocations of 1.95 and 1.76 MMCMD respectively.

3

Estimation of gas demand - existing consumers

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duction

The pattern of gas use in India has not been market driven. It has been based on allocations by the Government and has reflected the priorities of the Government. A change over to a market driven system, however, will not significantly alter the sectoral gas use. This is because allocations have been based on imputed values with the objective of simulating the market. The power and fertilizer units will continue to be the anchor customers. Industrial demand will be low on account of preponderance of small units and also because of the availability of cheap coal. However, energy intensive industries in the neighbourhood of anchor customers or along gas pipelines are expected to change over to gas. Gas use for domestic purposes will continue to be low as space heating is not required and the gas is used only for cooking. Once again, urban clusters along the pipeline routes could provide some demand for gas.

In estimating the gas demand, we have looked separately at the following sectors:

- existing gas consumers
- power
- fertilizer
- captive power generation
- industries
- domestic and commercial

The gas demand is being estimated in the context of an LNG project. What we therefore estimate is the additional demand over what will be met by domestic gas. Gas is now available in these seven states from the western offshore fields and the onshore fields in Gujarat. The gas available from these fields is projected to decline. For existing consumers, the gap between the requirement and the supply will increase. We estimate this gap. This gets added to the demand from new consumers, which is estimated separately for each sector. Adding up all these gives us the time profile of the demand. The imputed values of gas use in these sectors developed in Chapter 9 are then applied to get the price profile of the demand projections.

Demand from existing consumers

The gas supply networks

The HBJ gas pipeline network traversing these states has been described in Chapter 1. Apart from this, there is a pipeline grid linking the gas fields in Gujarat with the consumers in the state. These pipelines are shown in Map 3.1.

All existing consumers draw gas on the basis of allocations from the government. The state-wise allocations along the HBJ and the allocation of the local gas in Gujarat are shown in the Table 3.1. The unit-wise details are in Annexures 3.1.

Table 3.1 Statewise and sectorwise allocations (MMCMD)

States	Power	Fertilizer	Industries	City
Gujarat	9.46	5.51	9.21	0.39
Madhya Pradesh	0.00	3.22	0.98	0.00
Uttar Pradesh	5.12	8.80	5.15	0.00
Punjab	0.00	0.00	0.00	0.00
Haryana	1.95	0.00	0.62	0.00
Delhi	2.54	0.00	0.50	0.48
Rajasthan	1.95	1.76	0.00	0.00
Total	21.02	19.29	16.46	0.87

Source. GAIL

These allocations alongwith the internal requirement of GAIL add up to a demand of 59.02 MMCMD (14.76 mt). The allocations along the HBJ were by and large finalized by 1990. The initial allocations were for six fertilizer plants. Later when the gas availability increased, allocations were made to power plants and industrial units. The guiding principle was to allocate gas to sectors with the highest imputed values.

As against these allocations, the supply in the recent years has been as below

Table 3.2 Gas supply (MMCMD)

Year	Power	Fertilizer	Sponge Iron	Others	Total
1997/98	12.94	16.36	2.51	4.82	36.63
1998/99	13.74	16.87	2.041	5.11	37.76
1999/00	15.46	17.37	1.65	5.14	39.62

There is already an unfulfilled demand. In future the gap increases as shown below.

Table 3.3 Deficit for existing consumers (million tonnes)

Demand / supply		2001/2	2006/7	2011/12
Demand		14.76	14.76	14.76
Supply	Gujarat-ONGC	1.52	0.73	0.17
	Gujarat-non-ONGC	0.08	1.25[a]	2.00[b]
	Western-offshore	9.19	10.93[c]	8.07[d]
	Total	10.78	12.91	10.24
Deficit		3.98	1.85	4.52

[a] Includes 0.75 mt from Hazira field of GSPCL and 0.50 mt from offshore field of Cairns Energy. The production is scheduled to reach 1.0 mt by 2003 and 1.25 mt by 2004;

[b] Includes 1.0 mt each from GSPCL and Cairns. Output from Cairns could go up to 2.0 mt;

[c] Includes a production of 0.37 mt from anticipated reserves;

[d] Includes a production of 1.25 mt from anticipated reserves

In the above Table we have assumed that the demand will remain constant. The fields operated by ONGC in Gujarat and in the Western Offshore are old fields, which have entered the phase of declining production. The supply from these fields is projected to go down and the deficit for the existing consumers projected to increase. To some extent, the decline from the ONGC fields will be balanced by increase in production from the privately operated fields in Gujarat. The important ones are the Hazira field operated by GSPCL and the Offshore fields discovered by Cairns Energy Limited.

It is reasonable to assume that the future supplies would be shared by the various sectors in proportion to their allocations. The sectorwise deficits in 2006/07 and 2011/12 are estimated on that basis as shown in Table 3.3.

Table 3.4 Sectorwise deficits (million tonnes)

Year	Power	Fertiliser	Industries	City
2006/7	0.67	0.62	0.53	0.03
2011/12	1.65	1.51	1.29	0.07

4

Estimation of gas demand - power generation

wer consumption

The actual consumption of electric power and energy in the states as well as the shortages are reported by the Central Electricity Authority (CEA). Putting the two together, we get the unrestricted demand for energy in the states. As shown in the Table below, these have been growing quite rapidly in the states under study.

Table 4.1 Statewise electricity demand 1993/94 to 1998/99 (MU)

Year	Gujarat	Madhya Pradesh	Uttar Pradesh	Punjab	Haryana	Delhi	Rajasthan
1993-94	29794	24710	34336	19050	11472	11159	16084
1994-95	30872	27884	37320	20329	11739	12184	16948
1995-96	34975	31287	40158	20568	13171	13296	20178
1996-97	37495	33064	41618	21868	13849	14069	20101
1997-98	38788	32390	41320	22283	13276	15084	20427
1998-99	41702	35369	42619	24886	14162	16573	23802
CAGR	6.96	7.44	4.42	5.49	4.30	8.23	8.15

It is to be noted that the above figures refer to the demand at the bus bar and include the T&D losses.

This growth in demand has taken place at a time when the state GDP grew at the following rates.

Table 4.2 GDP (Rs. crores)

State	1993-94	1998-99
Gujarat	50069	74911
Madhya Pradesh	52752	65520
Uttar Pradesh	87555	114025
Punjab	30249	37154
Haryana	21665	28339
Delhi	19665	31099
Rajasthan	33025	45704

The energy elasticity over this period works out as shown in the Table below.

Table 4.3 Energy elasticity

State	Elasticity
Gujarat	0.81
Madhya Pradesh	1.78
Uttar Pradesh	0.80
Punjab	1.34
Haryana	0.76
Delhi	0.83
Rajasthan	0.84

As expected, the elasticities differ among the states depending on the sectoral use of electricity.

Power demand projections

The CEA also makes projections of power demand. These projections are revised every five years or so. The last such projection was published earlier this year as the 16th Electric Power Survey (EPS). The projections for the seven states are shown in the Table below.

Table 4.4 Projections of energy demand (MU)

Year	Gujarat	Madhya Pradesh	Uttar Pradesh	Punjab	Haryana	Delhi	Rajasthan
1999-00	41204	35947	43684	26052	15051	17452	25079
2000-01	43750	37266	46763	27874	16175	18432	26890
2001-02	46393	39167	50087	29824	17460	19454	28852
2002-03	49141	41517	53671	31961	18900	20553	30853
2003-04	51999	44045	57531	34215	20437	21730	32980
2004-05	54970	46765	61681	36596	22089	22991	35216
CAGR	5.93	5.40	7.14	7.03	7.97	5.67	7.03

It may be seen that the rate of growth in Gujarat, Madhya Pradesh, Delhi and Rajasthan are projected to come down from the rates achieved in the nineties. This is consistent with the growth taking place mostly in the industries and the services sectors, where lower energy elasticities are expected. On the other hand, Uttar Pradesh, Punjab and Haryana where the energy demand grew at lower rates in the nineties are projected to achieve much higher growth rates in the coming years. These projections are based on the growth projections made by the state governments in the various sectors. All these three states have projected aggressive growth in electrification of irrigation pumps. In addition, Punjab has projected a steep rise in industrial demand.

The 16th EPS has made annual projections up to 2004-05 and long-term projections for 2006-07, 2011-12, and 2016-17, the terminal years of the 10th. 11th and the 12th five-year plans. The projections are based on the analysis of past trends in electricity consumption in the following sectors.

- Domestic
- Commercial and miscellaneous
- Public lighting
- Public water works
- Irrigation and dewatering
- Industrial (HT above 1 MW, HT below 1 MW and LT)
- Railway traction and
- Bulk supply to non-industrial consumers

According to the CEA, these projections take into account the higher demand in the domestic sector due to the growth in internet connections. The projections have also considered the effects of the regulatory changes that the power sector is going through. The CEA holds extensive discussions with the power utilities in each state before making these projections. One major problem that makes such projections difficult is that agricultural supplies are not metered. The other problem is that there are large commercial losses. Both of these factors distort the sectoral consumption figures. In spite of this problem, earlier projections by the CEA conform quite closely to the unrestricted demand as shown in the Table below.

Table 4.5 Actual and projected energy demand (MU)

States		1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Gujarat	Actual	29794	30872	34975	37495	38788	41702
	Projected	28610	30609	33565	36009	38543	40946
M P	Actual	24710	27884	31287	33064	32390	35369
	Projected	25327	27018	29029	31137	33399	35658
U P	Actual	34336	37320	40158	41618	41320	42619
	Projected	34101	36561	39209	42114	45315	48663
Punjab	Actual	19050	20329	20568	21868	22283	24886
	Projected	19809	21151	22465	23988	25439	26937
Haryana	Actual	11472	11739	13171	13849	13276	14162
	Projected	13359	14572	15751	16990	18319	19684
Delhi	Actual	11159	12184	13296	14069	15084	16573
	Projected	11113	12177	13233	14395	15579	16787
Rajasthan	Actual	16084	16948	20178	20101	20427	23802
	Projected	16310	17927	19743	21577	23473	25491

Assuming that the GDP growth rates over the next five years remain the same as shown in Table 4.2 above, the energy elasticity of GDP increases in three of the states as shown in the Table below.

Table 4.6 Energy elasticity

State	Elasticity (93-99)	Elasticity (2000-05)
Gujarat	0.81	0.67
Madhya Pradesh	1.78	1.24
Uttar Pradesh	0.80	1.36
Punjab	1.34	1.77
Haryana	0.76	1.52
Delhi	0.83	0.55
Rajasthan	0.84	0.71

In view of the large increase in the consumption taking place in these states in the agricultural sector and the domestic sector the increases in the elasticities may appear to be acceptable. However, the divergence between projected and actual demand in the nineties was noticeable in these states. It is improbable that the jump in electricity consumption projected for Uttar Pradesh, Punjab and Haryana will actually take place. We have accordingly assumed that the growth in demand in these states would be restricted to the actual growth rates achieved in the nineties. For the other states we have adopted the 16th EPS projections. All subsequent references to the 16th EPS demand are to the demand as modified above.

The power supply position

Current shortages

All these states have been experiencing shortages in both energy and power as shown in the Table below.

Table 4.7 Energy and power shortages

Year	Peak Requirement MW	Peak Availability MW	Peak Deficit MW	Peak Deficit %	Energy Requirement MkWH	Energy Availability MkWh	Energy Deficit MkWh	En Defi
Gujarat								
Apr'01-May'01	7796	6598	1198	15.4	9593	8465	1128	1
1999-2000	7554	5962	1592	21.1	51202	46994	4208	[illegible]
1998-1999	7018	5877	1141	16.3	45685	42835	2850	[illegible]
Madhya Pradesh								
Apr'01-May'01	4751	3537	1214	25.6	4895	4070	825	1

Year	Peak Requirement MW	Peak Availability MW	Peak Deficit MW	Peak Deficit %	Energy Pequirement MkWH	Energy Availability MkWh	Energy Deficit MkWh	Energy Deficit %
1999-2000	6836	4808	2028	29.7	37198	34543	2655	7.1
1998-1999	6375	4770	1605	25.2	35407	33345	2062	5.8
Uttar Pradesh								
Apr'01-May'01	7000	6044	956	13.7	7735	6834	901	11.6
1999-2000	6580	5058	1522	23.1	44525	38800	5725	12.9
1998-1999	6642	5328	1314	19.8	42291	38138	4153	9.8
Punjab								
Apr'01-May'01	4245	4245	0	0	4285	4069	216	5.0
1999-2000	5029	5029	0	0	26335	26164	171	0.6
1998-1999	4451	4451	0	0	24884	24340	544	2.2
Haryana								
Apr'01-May'01	2550	2471	79	3.1	2550	2515	35	1.4
1999-2000	2527	2527	0	0	15950	15578	372	2.3
1998-1999	2416	2215	201	8.3	14106	13808	298	2.1
Delhi								
Apr'01-May'01	2995	2771	224	7.5	3240	3100	140	4.3
1999-2000	2850	2498	352	12.4	17635	17141	494	0.5
1998-1999	2703	2484	219	8.1	16500	16184	316	1.9
Rajasthan								
Apr'01-May'01	3450	3286	164	4.8	3795	3721	74	1.9
1999-2000	3672	3672	0	0	25155	24024	1131	4.5
1998-1999	3561	3498	153	4.2	23340	22766	574	2.5

Installed capacities

The current installed capacities (as on 31 May 2001) in the states are shown in the Table below. The locations are shown in Map 4.1.

Table 4.8 Installed capacity in the states (MW)

State	Sector	Hydel	Coal	Gas	Diesel	Wind	Nuclear	Total
Gujarat	State	547	3759	243	17	17	0	4583
	Private	0	1060	1430	0	149	0	2639
	Center	0	829	424	0	0	285	1538
Total		547	5648	2097	17	166	285	8761
Madhya Pradesh	State	912	3437	0	0	0	0	4351
	Private	0	0	0	0	22	0	22
	Center	0	1268	257	0	0	93	1618
Total		912	4705	257	0	22	93	5991
Uttar Pradesh	State	1510	4102	0	0	0		5612
	Private	0	0	0	0	0		0
	Center	201	2085	482	0	0	44	2812

State	Sector	Hydel	Coal	Gas	Diesel	Wind	Nuclear	Total
Total		1711	6187	482	0	0	44	8424
Punjab	State	2398	2130	0	0	0	0	4528
	Private	0	0	0	0	0	0	0
	Center	456	406	264	0	0	90	1216
Total		2854	2536	264	0	0	90	5744
Haryana	State	883	1102	0	3	0	0	1990
	Private	0	0	0	0	0	0	0
	Center	314	383	534	0	0	59	1290
Total		1197	1485	534	3	0	59	3280
Delhi	State	0	335	282	0	0	0	617
	Private	0	0	0	0	0	0	0
	Center	217	1797	207	0	0	87	2308
Total		217	2132	489	0	0	87	2925
Rajasthan	State	971	1475	38	0	6	0	2491
	Private	0	0	0	0	0.9	0	0.9
	Center	207	453	358	0	0	924	1942
Total		1178	1928	396	0	7	924	4434
All States	State	7225	16341	564	21	24	0	24175
	Private	0	1060	1430	0	173	0	2663
	Center	1395	7221	2527	0	0	1582	12725
Total		8620	24622	4520	21	197	1582	39562

In view of the current shortages and the increase in demand, all the states have taken up programs for installing additional generation capacity. The CEA, in its publication called 'Power on Demand' has listed out the various ongoing and new power projects under consideration in the states. With this list as the starting point, the present position was checked with the CEA and also discussed with the different State Electricity Boards. Based on these discussions, the projects which are likely to be commissioned by 2006-07 have been identified. These are shown below.

Table 4.9 Power projects to be commissioned by 2006-07

State	Plant	Capacity (MW)	Fuel
Gujarat	Akrimota	250	Lignite
Madhya Pradesh	Nil		
Uttar Pradesh	Rajghat	45	Hydel
Punjab	Shahpur Kandi	168	Hydel
Haryana	Dadupur + W Yamuna Canal	22	Hydel
	Small Hydel Projects	25	Hydel
Delhi	Pragati	230	Coal
Rajasthan	Suratgarh Extn.	250	Coal
	Ramgarh Extn.	70	Gas

State	Plant	Capacity (MW)	Fuel
	Jakham	5	Hydel
	Anas	45	Hydel
	Kota Extn	195	Coal
	Giral Lignite	250	Lignite

Table 4.10 Central sector projects to be commissioned by 2006/07

	Plant	Capacity (MW)	Fuel
NTPC	Nil		
NHPC	Chamera-II	300	Hydel
	Dhauli Ganga	280	Hydel
THDC	Tehri Dam-I	1000	Hydel
Others	Natpha Jhakri	1500	Hydel

As may be seen above, the additional capacity to be installed by 2006-07 in all the states comes to 3603 MW. Over the last five-year plan (1992-1997) and the current plan (1997-2002) the additional capacity installed in the country would be around 20,000 MW in each plan compared to the targets of more than 40,000 MW for each plan. Even when compared to these lower figures of actual achievement, the addition of 3408 MW over the 10th plan period in these states appears to be low. This can be explained only by the relatively better power position in the states of Punjab, Haryana, and Rajasthan and the financial difficulties being faced by the State Electricity Boards in all the states.

The power projects likely to be commissioned over the 11th plan period from 2007-12 are shown in the Table below. Map 4.2 shows the locations of the proposed power plants.

Table 4.11 Power projects to be commissioned between 2007/8 and 2011/12

State	Plant	Capacity (MW)	Fuel
Gujarat	Sardar Sarovar share	232	Hydel
	Share of Hirma	400	Coal
Madhya Pradesh	Bina	578	Coal
	Maheswar	400	Hydel
	Share of Hirma	300	Coal
	Sardar sarovar share	825	
Uttar Pradesh	Katpathar	19	Hydel
	Manerbali+Lakwavyasi	724	Hydel
	Tuini Plasu	42	Hydel

State	Plant	Capacity (MW)	Fuel
Punjab	Lehara Mohabbat	500	Coal
	Govindwal	500	Coal
	Share in Hirma	960	Coal
Haryana	Share in Hirma	500	Coal
Delhi	New Delhi TPS	350	Coal
Rajasthan	Wind Power	215	Wind
	Giral Lignite	125+125	Lignite
	Barsingsar	500	Lignite
	Share in Hirma	1200	Coal

Table 4.12 Central sector projects to be commissioned between 2007/8 and 2011/12

	Plant	Capacity (MW)	Fuel
NTPC	Sipat-I	1980	Coal
	Unchahar-III	500	Coal
	Kol Dam	800	Hydel
NHPC	Nil		
THDC	Tehri Dam-II	1000	Hydel
NPCIL	RAPP Extn.	1000	Nuclear
Others	Koteshwer	400	Hydel

Out of the projects listed by CEA in 'Power on Demand', the following projects have been excluded from the above lists.

Table 4.13 List of excluded power projects

State	Plant	Capacity (MW)	Fuel	Remarks
Gujarat	Ghoga	375	Lignite	No progress
	Mundra TPP	500	Coal	No progress
	Narmada	1000	LNG	Fuel supply not tied-up
	Jamnagar	500	Ref-resid	Viability under study
	Pipavav	2000	LNG	Fuel supply not tied-up
	Chharra	600	LNG	Fuel supply not tied-up
	Sabarmati	120	Coal	Abandoned
Madhya Pradesh	Bansagar	110	Hydel	No progress
	Khandwa	171	Naphtha	Not considered viable
	Narsingpur	166	Naphtha	Not considered viable
	Guna	330	Naphtha	Not considered viable
	Bhander	342	Naphtha	Not considered viable
	Raigarh	550	Coal	No progress
	Korba RPG	520	Coal	No progress

State	Plant	Capacity (MW)	Fuel	Remarks
	Korba East	1070	Coal	No progress
	Korba West	420	Coal	No progress
	Pench TPS	500	Coal	No progress
	Bhilai	574	Coal	No progress
	Pithampur	119	Diesel	Not considered viable
33	Ratlam	120	Diesel	Not considered viable
Uttar Pradesh	Anpara C	500	Coal	No progress
	Jawaharpur	800	Coal	No progress
	Partapur	2000	Coal	No progress
	Vishnuprayag	400	Hydel	No progress
	Srinagar	330	Hydel	No progress
Punjab	SYL Canal	50	Hydel	No progress
Haryana	Yamunagar	700	Hydel	No progress
Delhi	Bawana	421	Gas	Fuel supply not tied-up
Rajasthan	Jalipa	1000	Lignite	No progress
	Kapurdi	500	Lignite	No progress
	Dholpur	703	LNG	Fuel supply not tied-up
Central sector projects				
NTPC	Gandhar - II	650	LNG	Fuel supply not tied up
	Kawas - II	650	LNG	Fuel supply not tied up
	Faridabad	430	LNG	Fuel supply not tied up
	Gandhar - III	650	LNG	Fuel supply not tied up
	Kawas - III	650	LNG	Fuel supply not tied up
	Anta - II	650	Naphtha	Not considered viable
	Anta - III	650	LNG	Fuel supply not tied up
	Auraiya - II	650	Naphtha	Not considered viable
	Auraiya - III	650	LNG	Fuel supply not tied up
	Unchahar - III	500	Coal	No progress
	Vindhyachal - III	1000	Coal	No progress
	Sipat - II	2000	Coal	No progress
NHPC	Nabinagar	250	Hydel	No progress

Planning for generation capacity in 2006-7 and 2011-12

With the energy demand projected by the 16th EPS and the likely capacities being setup in the states, it is obvious that the energy and peak-load requirements will not be met. This is shown in the Table below.

Table 4.14 Energy requirement and likely availability

State	Installed capacity (MW)	Current Generation (MKWH)	Additional capacity (MW)		Energy availability (MKWH)		Energy requirement(MKW	
			2006-07	2011-12	2006-07	2011-12	2006-07	2011
Gujarat	8762	46994	250	1154	48374	54857	61683	816
M P	5991	34543	0	2789	34543	48498	51952	685
U P	8424	38800	1220	2443	43585	54634	60268	748
Punjab	5745	26164	466	2235	27998	40660	38284	500
Haryana	3280	15578	189	977	16322	21425	21417	264
Delhi	2925	17141	537	611	19615	22802	25672	337
Rajasthan	4434	24024	941	3346	28738	46891	40341	561
Total	39561	203244	3603	13555	219175	289767	318123	3913

In calculating the energy available from the new plants in Table 4.14 above, the PLF for the new plants have been assumed as shown below.

Table 4.15 PLF of new plants

Type of plant	PLF (%)
Hydel	45
Thermal above 500 MW	75
Thermal below 500 MW	68.5
Nuclear	71

These assumptions are in line with assumptions made by the CEA.

To arrive at the additional generating capacity required over and above the additional capacity considered above as likely, we have made the following assumptions.

Shortages

The power sector is going through important policy reforms. The progress of these reforms will determine the growth of production and utilisation of electricity. The gas demand has accordingly been estimated under two different scenarios - high reforms and low reforms. In the high reforms scenario we assume that

- power tariffs are revised annually by the regulators
- the orders of the regulators are implemented by the government
- T&D losses are reduced
- utilities start making profits
- power shortage is wiped out by 2011/12
- the price of urea is decontrolled by 2006.

In the low reforms scenario, the tariff reforms would be slower, the utilities would continue to depend on government subsidies. The improvement in T&D losses would be slower.

In the high reform scenario, the existing energy shortages continue till 2006/7 but disappear completely by 2011/12. An exception is made for Gujarat where the full energy requirement is assumed to be met as early as in 2006/7. The reason for this is that Gujarat is a highly industrialized and fast growing state where tolerance for shortages would be lower. In the low reform scenario, the current shortages persist till 2006/7 in all states and even in 2011/12, half the current shortages remain (all in percentage terms).

T&D losses

As noted above, the energy demand projections include T&D losses. The 16th EPS has assumed some improvement in T&D losses in the states as shown in the Table below.

Table 4.16 Improvement in T&D losses

	T&D losses (%)	
State	1998-99	2004-05
Gujarat	21.78	19.83
M P	20.30	19.70
U P	26.50	25.30
Punjab	18.91	18.38
Haryana	33.00	31.00
Delhi	48.00	42.80
Rajasthan	24.60	24.10

In the high reform scenario, we have assumed a further improvement of 2% in the T&D losses by 2006-07 and 5% by 2011/12 in the five states of Gujarat, Madhya Pradesh, Uttar Pradesh, Haryana, and Delhi where the electricity regulators are taking steps to see that the utilities improve their performance. In the other states the improvements in T&D losses would be as projected in the 16th EPS. In the low reform scenario, there is no improvement by 2006/7. However, by 2011/12 we assume an improvement of 2% compared to 16EPS projections.

PLF

With so little additional capacity coming in, the pressure on existing plants would be high and their performance is bound to improve. This has been the experience in the nineties. We assume that the PLF of all existing plants and the new plants will improve by 5%.

Captive generation

Between 1993/94 and 1998/99, the captive generation in the states has increased as shown in the Table below. The growth has been faster than the growth in the energy consumption by industrial consumers in the above 1 MW category. This is the category, which accounts for most of the captive generation.

Table 4.17 Energy use and captive generation (CAGR)

State	Energy use by large industry	Captive generation (1993-99)	Captive generation (1999-2005) 16th EPS Projections
Gujarat	5.26	13.09	3.21
M P	0.47	7.26	0.75
U P	2.29	9.15	5.56
Punjab	9.59	7.09	9.54
Haryana	3.32	4.58	7.12
Delhi	-9.35	-8.24	5.38
Rajasthan	8.35	14.41	2.02

Captive generation would depend on the growth rate in the industrial production and the price of power paid by the industry to the utilities. These prices are high because of the cross-subsidy between sectors. These cross-subsidies are being phased out. This should result in a reduction of power prices for the industry and therefore a reduction in captive generation. However, the projected growth in captive generation for Gujarat, Madhya Pradesh, and Rajasthan appear to be too low. Such a drop in captive generation is possible in the high reform scenario. For the low reform scenario, we assume that the growth rate for Gujarat and Rajasthan would be 10% and for Madhya Pradesh it would be 5%. For the other states, we have not changed the growth rates projected in the 16th EPS. The EPS energy demand projections exclude captive generation i.e. the demand is net of captive generation. However, for the three states in which we assume a faster growth rate in captive generation, the energy demand figures have been corrected.

With these assumptions, the energy deficits in the high reform case work out as below.

Table 4.18 High reforms - energy deficit in 2006-07 (MU)

16EPS	Existing shortages %	Shortages	Net after shortages	Improvement in T&D	Net requirement	Energy available	Deficit	80% PLF	90%PLF
61683	0	0	61683	1234	60449	52312	8137	1161	1032
51952	7.1	3689	48263	965	47298	37167	10131	1446	1285
60268	12.9	7775	52493	1050	51444	47807	3637	519	461
38284	0.6	230	38054	761	37293	30711	6582	939	835
21417	2.3	493	20924	418	20506	17838	2668	381	338
25672	2.8	719	24953	499	24454	21122	3332	475	423
40341	4.5	1815	38526	771	37755	31091	6664	951	845
299617		14720	284897	5698	279199	238048	41151	5872	5220

Table 4.19 High reforms - energy deficit in 2011/12 (MU)

States	16th EPS	Improvement in T&D	Net requirement.	Energy available	Deficit	80% PLF	90%PLF
Gujarat	81615	4081	77534	59268	18266	2606	2317
MP	68578	3429	65149	52286	12863	1835	1632
UP	74818	3741	71077	59894	11183	1596	1418
Punjab	50011	2501	47510	44280	3230	461	410
Haryana	26435	1322	25113	23348	1765	252	224
Delhi	33712	1686	32026	24562	7464	1065	947
Rajasthan	56133	2807	53326	50430	2896	413	367
Total	391302	19565	371737	314068	57669	8229	7315

It is likely that the net deficit in 2006/7 will remain as it is unlikely that any additional capacity would be commissioned by that time. The only possibility is to commission units based on imported gas. For 2011/12, there is enough time to get coal based or hydel projects approved and to set them up. However, if gas is committed early enough, gas based units would get preference and hence we count the entire additional capacity towards the potential gas demand.

In the low reform scenario, the deficit in 2006/7 would be slightly lower and so would be the additional capacity required as shown below.

Table 4.20 Low reforms - energy deficit in 2006-07 (MU)

States	16th EPS	Existing shortages %	Shortages	Net after shortages	Captive	Net requirement	Energy available	Deficit	80% PLF	90%PLF
Gujarat	61683	0	0	61683	5200	56483	52312	4171	595	529
MP	51952	7.1	3689	48263	1712	46551	37167	9384	1339	1190
UP	60268	12.9	7775	52493		52493	47807	4686	669	594
Punjab	38284	0.6	230	38054		38054	30711	7343	1048	931
Haryana	21417	2.3	493	20924		20924	17838	3086	440	391
Delhi	25672	2.8	719	24953		24953	21122	3831	547	486
Rajasthan	40341	4.5	1815	38526	1396	37130	31091	6039	862	766
Total	299617		14720	284897	8308	276589	238048	38541	5500	4889

Table 4.21 Low reforms - energy deficit in 2011/12 (MU)

States	16thEPS	Shortages %	Half-shortage	Less improvement	Captive	Net requirement	Energy available	Deficit	80% PLF
Gujarat	81615	4.1	3346	1565	11910	64793	56689	8104	1156
MP	68578	3.55	2435	1323	3267	61554	50352	11202	1598
UP	74818	6.45	4826	1400		68592	59894	8698	1241
Punjab	50011	0.3	150	997		48864	38090	10774	1537
Haryana	26435	1.15	304	523		25608	20124	5484	783
Delhi	33712	1.4	472	665		32575	24562	8013	1143
Rajasthan	56133	2.25	1263	1097	3091	50682	42693	7989	1140
Total	391302		12795	7570	18268	352668	292404	60264	8599

In 2011/12, however, the deficit actually goes up. This is because we assume that the Hirma super thermal project would not come through. The reason is that this is a mega project which can reach financial closure only under optimal conditions and there is no chance of this coming about in a low reform scenario. The additional gas based capacity required in this case would be as shown in Table 4.21 above.

The difference in this case is that no additional capacity can be set up to meet these deficits for the same reasons as in the case of Hirma. However, we need not take the potential gas demand as zero. If the reforms do not go through, the higher cost of generation cannot be passed on to the consumer. The state government may even then try to meet the higher costs through subsidy. We therefore assume that even in the low reform case, the deficits in Gujarat, Delhi and Rajasthan would be met while only half the deficits in Uttar Pradesh and Madhya Pradesh are met. This means that the additional capacity to be set up would be 2673 MW in 2006/7 and 4319 MW in 2011/12. We take these capacities in computing the potential gas demand.

In the above analysis, we have assumed that the progress of reforms would be either high or low in all the states together. Although there are synergies in reforms between the states, this is by no means certain. The additional capacity requirements for the states worked out in Tables 4.18 to 4.21 could be combined in different permutations to cover the various possible scenarios.

In planning the capacity for 2006/7 and 2011/12, we have not considered the peak load, assuming that peaking shortages would remain. Meeting these shortages would require even higher capacities to be installed and that is plainly unlikely. We have also not considered the retirement of existing plants as we believe the old plants would be covered under R&M schemes and would not be retired when new capacity is in short supply.

With the above assumptions, the gas demand from the power sector comes out as below. This assumes a calorific value of 8500 Kcals/cu.mtr. of gas and a turbine efficiency of 56%. The PLF is already assumed at 90%.

Table 4.22 Gas demand from power sector (million tonnes)

Year	High reforms	Low reforms
2006/7	5.10	2.61
2011/12	7.15	4.22

Inter-state power transfers

Inter-state power transfers do not normally take place between the State Electricity Boards. Transfers against short term agreements are more common. The bulk of the inter-state movement takes place because the central sector generators like NTPC and NHPC sell power to a number of states including the host state. The share out used to follow guidelines of the central government but would henceforth be agreed between the power producers and the states. The transmission capacity for interstate exchanges has accordingly come up to meet the needs of evacuation from NTPC/NHPC plants. The Powergrid Corporation now has the responsibility of planning and setting up such lines. The Central Electricity Regulatory Commission approves the transmission tariff for inter-state lines. The power grid map of India is at Map 4.3.

A relevant question for the present study is whether the energy needs of individual states have to be met by generation within the state or could the generation take place in Gujarat or Madhya Pradesh and power transmitted to the other states. Each state would prefer to maximize generation within the state. This is partly because of advantages like local employment, etc. and partly because inter-state grids are not adequate in capacity or reliability. A large scale transfer of power between states of 1000 MW or more would most probably require augmentation of transmission capacity but there is no simple way of calculating the transmission cost. The Hirma super thermal plant being set up in Orissa to feed over 3000 MW into the western states is a benchmark case. In this case, a new trunk line from Hirma to Jaipur has been planned with spur lines going to other states. The pooled transmission cost comes to 60 paise/kwh. The delivered cost of Hirma power will be Rs 2.34/kwh. The cost of generation for a few other pithead stations and hydel power would be as below.

Table 4.23 Cost of generation (Rs./kWh)

Power plant	Generation costs
Korba, MP	2.42
Singarauli, UP	2.42
Karanpura, Bihar	2.42
Talcher, Orissa	2.40
Tehri, UP (Hydel)	2.98

It is difficult to compare the delivered costs due to the problems mentioned above.

Payment for power

The state electricity boards are required by law to earn a 3% return on their assets but none of them do so even after getting grants from the government. The position in the states under study is shown below.

Table 4.24 Profitability of SEBs (with subsidies) (Rs. Crores)

State	1996/97	1997/98	1998/99	1999/2000	2000/01
Gujarat	111	119	126	- 1367	- 1446
Madhya Pradesh	- 163	- 812	- 1664	- 1861	- 2200
Uttar Pradesh	- 1821	- 1853	- 1962	- 2543	- 2784
Punjab	- 603	- 943	- 1314	- 1304	- 1308
Haryana	6	- 32	- 475	- 532	- 820
Delhi	- 626	- 760	- 1209	- 1209	- 1186
Rajasthan	63	65	65	- 1512	- 1352

The outstanding dues payable to central power producers and coal supplier are shown in the Table below.

Table 4.25 Outstanding dues as on 31st March, 2001 (Rs. Crores)

SEBs/States	REC	NTPC	NEEPCO	DVC	NHPC	NPC	PFC	PGCIL	Coal Companies
Andhra Pradesh	1	21	0	0	0	113	0	0	494
Arunachal Pradesh	4	0	17	0	1	-	0	9	-
Assam	175	53	703	2	0	-	0	203	0
Bihar/BSEB	445	3116	0	1973	36	-	0	194	300
Gujarat	1	224	0	0	0	88	0	0	589
Goa	0	2	0	0	0	-	0	0	-
Haryana	0	344	0	0	679	172	1	7	52
Himachal Pradesh	0	38	0	0	72	15	0	1	-
Jammu & Kashmir	1	34	0	0	838	183	0	157	-
Karnataka	4	273	0	0	0	57	0	21	390
Kerala	0	531	0	0	0	9	0	16	143

SEBs/States	REC	NTPC	NEEPCO	DVC	NHPC	NPC	PFC	PGCIL	Coal Companies	Total
Madhya Pradesh	1407	1427	0	0	0	789	14	57	1005	4709
Maharashtra	0	652	0	0	0	2	0	13	766	1433
Manipur	3	0	129	0	21	-	0	50	-	203
Meghalaya	31	0	13	0	2	-	0	11	-	57
Mizoram	5	0	37	0	5	-	2	5	-	55
Nagaland	0	0	61	0	8	-	0	22	-	91
Orissa GRIDCO	0	554	0	0	19	-	0	0	-	573
Punjab	0	98	0	0	298	3	0	3	250	651
Pondicherry	0	35	0	0	0	0	0	2	36	72
Rajasthan	12	407	0	0	70	80	0	27	85	680
Sikkim	0	37	0	0	2	-	0	13	-	53
Tamil Nadu	1	452	0	0	0	22	0	1	817	1293
Tripura	1	0	46	0	3	-	0	10	-	60
Uttar Pradesh	860	2732	0	0	700	579	0	0	408	5279
WBSEB	519	1457	0	813	18	-	0	75	301	3183
WBPDC									689	689
DPL									186	186
Delhi (DVB)	0	2910	0	0	510	182	0	157	20	3778
Total	3470	15395	1006	2788	3279	2294	18	1062	6531	35842

The payments to IPPs are much better as these are guaranteed in the PPAs. The mechanism of payment varies from case to case depending on the PPA. Typically, the utilities open letters of credit in a bank. The power producer sends monthly invoices to the utilities. The utilities are required to approve them within a specified time period and return them to the IPP. The approved invoice can be produced in the bank and payment obtained against the LC. This arrangement could cover only the fixed charges or could cover all dues. The LCs are to be periodically renewed by the utility. In addition, some states have allowed escrow cover for these dues.

The system seems to be functioning satisfactorily. Except in the case of Enron, no IPP has had to take recourse to the guarantee. The IPPs are expected to enter into similar LC arrangements with the fuel suppliers and furnish bank guarantees to cover their take-or-pay obligations.

Good quality demand

The Table below shows some of the indicators of the financial health of the SEBs in the states under study.

Table 4.26 Finance health of SEBs

States	Unit cost (cents/kwh)	Unit tariff (cents/kwh)	Loss ($ million)	RoR (%)	Subsidy /govt. receipts (%)	Reforms (Rank)
Gujarat	7	5	314	-27	16	4
Madhya Pradesh	6	4	478	-47	16	5
Uttar Pradesh	6	4	605	-15	8	3
Punjab	5	4	284	-32	-0.75	7
Haryana	6	5	178	-29	16	6
Delhi	10	7	258	-72	24	2
Rajasthan	7	4	294	-34	10	1

It is evident from the above Table that all the SEBs are in the red and the demand from the power sector will not be bankable unless the situation improves. Although reforms have started in all the states, the progress of reforms has not been uniform. In the above Table, we have ranked the states according to the progress in reforming the power sector. The ranking has taken into account the number of tariff orders passed by the regulatory commissions, the governments willingness to implement these orders, the improvement in the T&D losses and in the control of theft of power, etc.

Inspite of the situation obtaining in the SEBs, the bankers may be able to accept the power sector demand when NTPC is the power producer. The strength of the NTPC balance sheet may provide the necessary comfort to the bankers. It may be mentioned that inspite of the huge accumulated dues of the states payable to NTPC, NTPC has not defaulted in payments to Coal India for coal supplies or to GAIL for gas supplies. On this analogy, the gas supplier may also expect prompt payment from NTPC for gas supplies even if NTPC is temporarily unable to secure payment for power supplied to the SEBs.

We have seen earlier that NTPC has a number of expansion projects under consideration (Table 4.13). These have not been included in the lists of projects likely to be commissioned, as gas supplies have not been tied up. NTPC has indicated during discussions that if gas is available, they may be able to take up three such expansion projects adding upto 1950 MW for commissioning by 2006/7. We have accordingly considered this in computing the good quality demand from the power sector in 2006/7. By 2011/12, NTPC would be in a position to implement all the projects under consideration. However, the demand in the low reforms scenario would be only 4319 MW, which can be supplied from NTPC's projects. Accordingly, we have taken this for the good quality demand number from the power sector irrespective of the progress of reforms. The gas demand numbers so computed are 7.63 MMCMD (1.91 mt) in 2006/7 and 16.89 MMCMD (4.22 mt) in 2011/12.

5

Estimation of gas demand - urea production

The trend in urea consumption

Seventy-five per cent of the fertilizer used in India is used in the production of foodgrains, namely, rice, wheat, pulses and sugarcane. Eighty-five per cent of the nitrogen required is applied in the form of urea. The nutrients - N, P and K - are ideally used in the proportion of 5.9:2.4:1. However, since 1992, N has been applied in excess owing to the price control on urea. It is expected that this distortion would be corrected when the urea price is decontrolled. The intensity of fertilizer use in India is low at 75 kg/hectare as very little fertilizer is used in non-irrigated lands.

Urea consumption in the country has increased at an annual rate of about 5% from 14 million tonnes in 1990/91 to 20 million tonnes in 1998/99 as shown below.

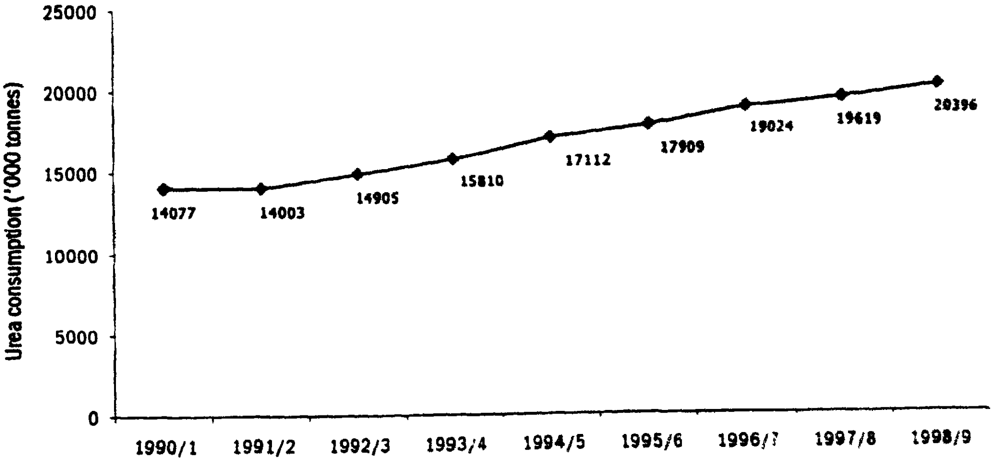

Figure 5.1 Urea consumption in India
Source. Fertilizer Association of India

While most of the urea consumed in the country has been produced domestically, a part of the requirement has been imported. Urea consumption and imports over the past decade is in the Table 5.1.

Table 5.1 Urea imports by India (1991-99)

Year	Urea consumption (million tonnes)	Urea imports (million tonnes)	Imports as % of consumption
1991-92	14.00	0.39	3
1992-93	14.91	1.86	12
1993-94	15.81	2.84	18
1994-95	17.11	2.88	17
1995-96	17.91	3.78	21
1996-97	19.02	2.33	12
1997-98	19.62	2.39	12
1998-99	20.40	0.56	3

Source. Fertilizer Association of India

Over the last two years, the consumption of urea has not shown any growth and the import has dropped to zero last year.

The import price of urea has fluctuated widely, sharply increasing whenever India and China increased their imports. The international prices since 1970 are shown in the Table 5.2.

Table 5.2 International urea prices

Year	Pnce at current $ (per MT)	Year	Pnce at current $ (per MT)	Year	Pnce at current $ (per MT)
1971	46.00	1980	222.10	1989	132.20
1972	59.30	1981	216.00	1990	157.00
1973	94.80	1982	158.80	1991	172.00
1974	315.80	1983	135.40	1992	140.30
1975	198.00	1984	171.30	1993	106.75
1976	112.00	1985	136.30	1994	147.92
1977	127.40	1986	107.00	1995	211.50
1978	144.80	1987	116.60	1996	205.48
1979	172.90	1988	155.00	1997	103.00
				1998	91.00

Source. EPW July 1999

The long-term average cif price at Mumbai works out to $150/MT.

Urea demand projections

Fertilizer demand projections are based on projections of growth in agricultural production. The agriculture sector has faced some major problems after the economic reforms of the early nineties. The production actually decreased in 1995-96 and 1997-98. The overall growth rate in foodgrains production in the nineties was 2.7%. The Fertilizer Association of India (FAI) estimates that the foodgrain production in India in 2011/12 will reach 340 million tonnes. This implies a growth rate of 4% over 1999-2012. There is some uncertainty at present as to the impact that the WTO agreements would have on agriculture. There could be a major shift from crops grown for self-consumption to cash crops and exportable crops. However, these factors can be taken into account only after more information becomes available and we have adopted the FAI estimates of foodgrain production.

To project the fertilizer requirement in 2011-12, we assume that one ton of fertilizer increases foodgrain production by 10 tonnes. This is higher than a figure of 7.5 tonnes also adopted in some forecasts but we assume that improvements in water management expected in future would make the higher yields possible. The foodgrains production in 1998-99 was 204 million tonnes. An increase of 136 million tonnes of foodgrains would require an additional 13.6 million tonnes of all fertilizers. Assuming that foodgrains will account for 75 per cent of fertilizer consumed as at present, the total additional requirement would be 18 million tonnes in terms of N, P and K, with the additional urea requirement of 20.7 million tonnes. Adding this to the consumption of 20.4 million tonnes in 1998-99, we get a requirement of 41.1 million tonnes by 2011-12.

Likely production capacity

It is, of course, not necessary to produce all the urea domestically. However, the government would like to restrict the imports on grounds of food security. Keeping imports down to the level of 20% of consumption would mean that we produce 33 million tonnes by 2012. The current production capacity is around 20 million tonnes. Pending a detailed exercise to estimate future urea demand, the government has decided not to approve any new urea plant before 2003. The proposals for four new plants with a total capacity of 3 million tonnes at Thal, Nellore, Gorakhpur and Hazira were pending for government approval at the time the ban on new capacity was imposed. These plants are likely to be cleared after 2003 and could be set up in the 2008-10 period. A joint venture project with the Oman Oil Company for a 1.5 million tonnes unit in Oman is also at an advanced stage of discussion.

If all the four units now held up for approval are cleared and the Oman project comes on stream, we will have an additional capacity of 4.5 million tonnes. The government would, therefore encourage additional capacity to the extent of another 8-9 million tonnes.

Choice of feedstock and potential gas demand

The oldest urea plants in the country were based on coal and fuel oil. These are now practically defunct. The plants set up in the 70's and 80's were based on naphtha. In the late 80's and the 90's, natural gas from the western offshore fields was made available through the HBJ pipeline and a number of gas based urea plants were set up.

The fuelwise breakup of production capacity in the seven states under study is shown in the Figure 5.2.

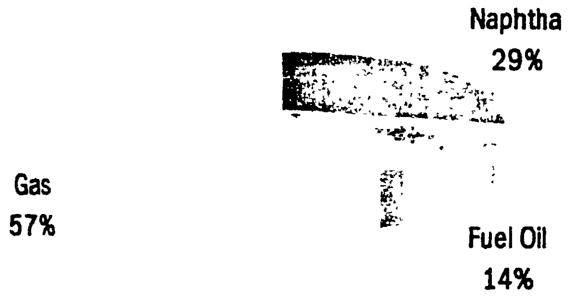

Figure 5.2 Share of fuels in installed urea capacity

Under the existing controlled price regime for urea, the urea producers are allowed retention prices, which compensate them fully for their capital costs and variable costs including the cost of feedstock. The urea plants based on different feedstocks do not have to compete against each other. Urea is sold on the basis of linkages decided by the government, the cost of transport from the plant to the consumption point being met by the government. A maximum price of Rs. 4,600/MT is payable by the farmers no matter where they are located.

In these circumstances, the feedstock choice is guided by availability and not the price. However, the present arrangement is proving to be costly for the government. As the average cost of production is greater than the retail price of urea, the deficit has to be met by a government subsidy. The burden of fertilizer subsidies on the budget of central government has grown dramatically over the years from Rs. 505 crores in 1980/81 to Rs. 13,244 crores in 1999/00. Driven by the increasing subsidy, the government is considering a phased decontrol of urea prices. The Expenditure Reforms Commission has recommended a complete decontrol of the urea price by April 2006. Earlier attempts by the government to decontrol the urea price were not successful and it is not clear if the government can implement this recommendation. As in the case of the power sector, we may think of a high reform scenario and a low reform scenario.

In the high reforms scenario, the decontrol could go through in 2006 and in the low reforms scenario it could be postponed. We assume that it would be postponed to 2010. Moreover, both power sector reforms and fertiliser sector reforms are opposed by the same force - the farmers' lobby. We are, therefore, justified in assuming that high reforms in the power sector would coincide with high reforms for the fertiliser sector.

Conversion from naphtha

Once the urea price is decontrolled, the urea producers will have to compete against each other and also against imports. The import of urea is now canalized but under the WTO Agreement, urea will have to be put under OGL. The domestic industry may then be protected by a suitable tariff. The government has appointed a task force to examine the feasibility of setting up new coal based urea plants. However, such plants are not expected soon. Domestic gas and LNG would be the natural choice for feedstock to the extent they are available. No new naphtha based is likely to be put up and the existing naphtha based plants would have to change over to gas.

Naphtha is now under OGL and it can be imported by anyone. Naphtha produced domestically is now sold at import parity prices. Nearly 2 million tonnes of naphtha is now exported. With new refinery capacity planned to be set up, the surplus of naphtha would increase. A part of this surplus naphtha may be converted into gasoline but a part of it would have to be exported. In such a situation, inland refineries in north India such as Mathura, Panipat and Bhatinda may drop their prices to export parity levels. This would benefit naphtha based urea producers in these states.

In chapter 4 we calculate the gas prices at which these urea producers would change to gas. We consider it feasible that regassified LNG can be supplied to these units at such prices and accordingly we have included the demand from these units in the potential gas demand for urea production. In the high reform scenario, it would be imperative for these units to change to gas by 2006. We assume that this demand would materialize by 2006 even in the low reform scenario as the government would be able to persuade these units to change to LNG as soon as it is available in order to reduce the fertiliser subsidy.

Capacity expansion

The second component of the potential gas demand from this sector would come from capacity expansion. After price decontrol, the urea produced in northern and western India would be consumed within the area, as it would not be feasible to move urea to southern India and compete with local production or imports. The installed capacity for urea in these states is 13.79 million tonnes as shown in the Table 5.3.

Table 5.3 Existing urea plants

Plant	State	Promoter	Feedstock	Capacity (000' tonnes)	Production ('000 tonnes) 1998
Bharuch	Gujarat	GNFC	Fuel Oil	594	660.8
Vadodara	Gujarat	GSFC	Naphtha, Natural Gas	367.2	323.9
Kalol	Gujarat	IFFCO	Natural Gas, Ass. Gas	544.5	491.2
Hazira	Gujarat	Kribhco	Ass. Gas	1452	1517
Gadepan, Kota	Rajasthan	Chambal Fertilizers		1550	956.8
Unit I			Ass. Gas	774.8	
Unit II			Naphtha	775.5	
Kota	Rajasthan	SFC	Naphtha	330	393.2
Bathinda	Punjab	National Fertilizers Limited	Fuel Oil	511.5	503.7
Nangal	Punjab			650	
Unit I			Naphtha	320	221.5
Unit II			Fuel Oil	330	388.5
Panipat	Haryana	National Fertilizers Limited	Fuel Oil	511.5	535.7
Panki	Uttar Pradesh	Duncans Industries	Naphtha	675	732.9
Gorakhpur	Uttar Pradesh	Fertilizer Corporation of India	Naphtha	284.9	
Phulpur	Uttar Pradesh	IFFCO		1221	1404
Unit I			Naphtha	495	568.9
Unit II			Naphtha	726	835.5
Aonla	Uttar Pradesh	IFFCO		1452	1690
Unit I			Ass. Gas	726	851.6
Unit II			Ass. Gas	726	838
Jagdishpur	Uttar Pradesh	Indo Gulf	Ass. Gas	726	1020
Shahjahanpur	Uttar Pradesh	Oswal Chemicals	Ass. Gas	726	890.7
Babrala	Uttar Pradesh	Tata Chemicals	Ass. Gas	742.5	878.5
Vijaipur	Madhya Pradesh	National Fertilizers Limited	1452	1717	
Unit I			Ass. Gas	726	854.7
Unit II			Ass. Gas	726	861.9

The urea plant locations are shown in Map 5.1. The trend in urea consumption in these states is shown in Table 5.4.

Table 5.4 Urea consumption in the states 1995-98 (million tonnes)

Years	Delhi	Haryana	Punjab	Rajasthan	Uttar Pradesh	Gujarat	Madhya Pradesh	Total
1995/96	0.033	1.144	1.997	0.932	4.263	0.971	1.022	10.36
1996/97	0.037	1.214	1.877	1.057	4.443	1.052	1.184	10.86
1997/98	0.036	1.252	1.925	1.132	4.687	1.203	1.373	11.61

Years	Delhi	Haryana	Punjab	Rajasthan	Uttar Pradesh	Gujarat	Madhya Pradesh	Total
1998/99	0.025	1.284	2.102	1.008	4.881	1.174	1.308	11.78
CAGR%	-8.0	3.9	1.7	2.7	4.6	6.5	8.6	-

Uttar Pradesh has the highest urea consumption among all states accounting for about 24% of total urea consumption in the country. Punjab ranks second in the share of urea consumption. The seven states considered in this study together accounted for about 58% of the total urea consumption in India in 1998/99. The share of the states in total urea consumption 1998/99 is shown in the Figure 5.3.

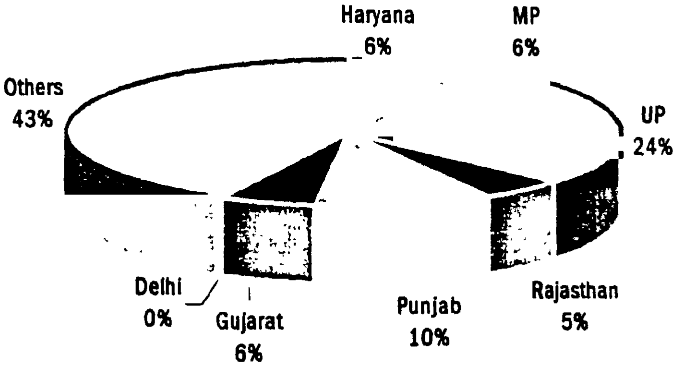

Figure 5.3 Share of states in total urea consumption in 1998/99
Source. Fertilizer Association of India

We have projected above that the urea consumption in the country will reach 41 million tonnes by 2011/12. Assuming that 58% of the total consumption will be accounted for by these states as at present, the consumption in these states will be 24 million tonnes. This means that these states could support another 10 million tonnes of urea capacity. A more detailed projection of fertilizer requirement in these states has not been possible in the absence of the necessary data.

We have noted that two units have been proposed at Hazira in Gujarat and Gorakhpur in Uttar Pradesh. Hazira would be an expansion project and the Gorakhpur plant would be set up after decommissioning an existing plant at the site. Both these units would enjoy a price advantage over completely new units. The gas based plants along the HBJ are all twin unit plants (2 x 726,000 TPA) except the plants at Jagdishpur, Shajahanpur and Babrala. Second units could be set up at all these sites. The Punjab government has proposed a new unit at Sangrur in Punjab. The chances of this unit coming up in a competitive situation are low. We therefore take an additional capacity of 3.5 million tonnes in computing the potential gas demand. In view of the ban on sanctioning new

capacity till 2003, the earliest these plants could come up is 2007. We have assumed that starting 2007, one new plant would come up each year.
In the high reform scenario, the naphtha plants would convert to gas in 2006 as soon as the urea price is decontrolled. The expansion plants also come up in time starting 2007. In the low reform scenario, the price decontrol is pushed back to 2010 and so are the expansion projects due to the difficulties in increasing subsidy. However, even in the low reforms scenario, the demand from naphtha conversion comes about in 2006/7 as the government would be interested in this conversion to reduce subsidy and should be able to persuade naphtha based units to change over to LNG as soon as it is available.

Assuming that 635 cubic metres of gas is required per tonne of urea, the feedstock requirement of a standard 726,000 TPA plant comes to 1.26 MMCMD. If the requirement for captive generation is included, the requirement per plant comes to 1.5 MMCMD.

The time profile of gas demand then works out as shown in Table 5.5.

Table 5.5 Additional gas demand by 2010

	High reform scenario		Low reform scenario	
Year	MMCMD	Million tonnes	MMCMD	Million tonnes
2006/07	6.92	1.73	6.92	1.73
2007/08	8.42	2.11	6.92	1.73
2008/09	9.92	2.48	6.92	1.73
2009/10	11.42	2.86	6.92	1.73
2010/11	12.92	3.23	8.42	2.11
2011/12	14.42	3.61	9.92	2.48

Creditworthiness of demand

In the fertiliser sector the plants are owned by reputed companies such as Tata, Oswal, Birlas, Duncans and the Sriram group. In the public sector, the concerned units belong to IFFCO and KRIBHCO, both well managed and profitable companies. Unlike the power sector where the progress of reforms is crucial to the viability of power producers, reforms in urea pricing will create problems for urea producers in the short run by exposing them to competition. While naphtha based units will have to change to gas, it is expected that gas based units will be able to negotiate the required level of protection and to expand production capacity. Food security being important to the government, urea producers have a lot of leverage. In the absence of protection, none of the units would be viable against imported urea. Even with protection against imports, not all the producers may do well under competition. However, all of them have established brand names and marketing networks and no major changes in the market shares are foreseen at present.

6

Estimation of gas demand - industry

Introduction

Energy use in industry is reported annually by the Central Statistical Organisation. The latest available report is for 1997/98. The energy consumption by fuel type for the states under study is at Annexure 6.1. The entire demand reported cannot be converted into gas demand as it is not possible for all the units to change over to gas. However, the list helps us in identifying the energy intensive industries in these states. On this basis we identify the cement, paper and pulp, glass, sugar, textiles and chemical units as the energy intensive industries. On the basis of available data we have gone into the details of the cement, paper and pulp and the glass industries. The sugar industry has not been considered as most of their fuel need is met by bagasse. Up to date data on the textile and chemical units was not available and hence these two sectors have been left out. Demand from these sectors has to be established by a detailed survey. One other industry which has been allocated gas preferentially due to the high imputed value of gas is the sponge iron industry. In the states under study there are two sponge iron units now in operation. However, on account of the low international price of scrap iron, no new gas-based sponge iron unit has been set up in recent years. Additional capacity is coming from small coal-based units only. Accordingly, the sponge iron industry has also not been considered for calculating the gas demand.

The cement industry

The installed capacity of cement units, as of March 2000, is available from the Cement Statistics 2000 compiled by the Cement Manufacturers' Association (CMA). The total capacity of large cement plants in the states under consideration have been listed in the Table below.

Table 6.1 Installed capacity of large cement units (million tonnes)

State	Installed capacity
Delhi	0.5
Haryana	0.17
Punjab	1.34

State	Installed capacity
Rajasthan	14.53
Uttar Pradesh	4.05
Gujarat	12.15
Madhya Pradesh	26.23
Total	**58.97**

Source. Cement Manufacturers' Association

Unit wise details have been provided in Annexure 6.2. The cement plant clusters have been shown in Map 6.1.

Capacity utilization in the cement industry is about 86%. Most of the cement production in India is done using the dry process. According to the CMA, the energy consumption ranges from 800 – 1060 kcals/kg of cement. An average of 930 kcals/kg has been used for evaluating the energy requirement for cement production in the states. Consequent gas demand has been estimated using a gas calorific value of 8500 kcal/m^3. The plants of MP and UP have not been considered as they are too close to coalfields. In the other states, we have considered the demand only from units with capacities above 2 million tonnes. For subsequent years, we have assumed a 6% growth rate in production in consultation with the industry. The results are in the Table below.

Table 6.2 Estimation of gas demand for cement industries

	Unit	2000	2006	2011
Total installed capacity in India	Million tonnes	110.1		
Total cement production in India	Million tonnes	94.21		
Production as a % of installed capacity	%	86		
Total installed capacity in states	Million tonnes	58.97		
Production in states	Million tonnes	50.71		
Total capacity considered	Million tonnes	10.23		
Total production considered	Million tonnes	8.80		
Energy requirement for cement production	kcal/kg	930		
Total energy requirement in states	Million kcal	8181954		
Calorific value of gas	kcal/m^3	8500		
Gas demand	MMCMD	2.6	3.7	5.0

The paper and pulp industry

The installed capacity of paper and pulp units, as of 1998/99, is available from INPAPER Protech Directory of Indian Paper Manufacturers & Allied Industry. Installed capacities of 10 largest units from each of the seven states have been considered and the corresponding total capacity tabulated below.

Table 6.3 Installed capacity of paper and pulp units (tonnes per annum)

State	Installed capacity
Delhi	3,300
Haryana	1,15,000
Punjab	2,22,468
Rajasthan	9,640
Uttar Pradesh	318,100
Gujarat	385,500
Madhya Pradesh	342,640
Total	13,96,648

Source. Indian Paper Manufacturers and Allied industry

Location and installed capacity details of the paper units are annexed as Annexure 6.3. The paper mill clusters in the region have been shown in Map 6.2.

According to industry experts, capacity utilization in the paper and pulp industry is about 70%–80%. An average of 75% has been considered for our analysis. Production has been projected to 2011/12 using an annual growth rate of 6% based on discussion with the industry. A survey done by TERI in 1995 in various states of India estimated that the average energy consumption is 9590 kcal/kg of paper production. The energy required to meet the projected production to 2011 is translated into gas demand using a calorific value of 8500 kcal per cubic metre of gas. Only the units with capacities of 50,000 tonnes and above have been considered. Once again, we have assumed a growth rate of 6% in the production. The results are in the Table below.

Table 6.4 Estimation of gas demand for paper and pulp industries

	Unit	1999	2006	2011
Total installed capacity in states	Tonnes	13,96,648		
Total installed capacity considered	Tonnes	8,34,160		
Production as a % of installed capacity	%	75		
Production in states	Tonnes	10,47,486		
Production considered	Tonnes	6,25,620		
Energy requirement for cement production	kcal/kg	9590		
Total energy requirement in states	Million kcal	5999696		
Calorific value of gas	kcal/m^3	8500		
Gas demand	MMCMD	1.93	2.90	3.89

Glass units

Industrial use of Liquefied Petroleum Gas (LPG) in the states under consideration is mainly by glass units. Gas demand from the glass industry can be estimated by converting LPG consumption on calorie equivalence. Ten districts from each state, having the highest bulk LPG consumption have been considered for estimating gas demand. LPG sales for these districts have been detailed in Annexure 6.4 and the locations have been shown in Map 6.3. The largest glass units are concentrated in the states of Punjab, Haryana and Uttar Pradesh.

Bulk LPG sales in the districts considered, amounted to 327,279 tonnes. The sales have been projected to 2006 and 2011 using an annual growth rate of 6%. The corresponding gas demand projections is tabulated below.

Table 6.5 Gas demand from glass industry

	Unit	2000	2006	2011
Bulk LPG sales	tonnes	327279.00		
Calorific value of LPG	kcal/kg	11300.00		
Calorific value of gas	kcal/m^3	8500.00		
Gas demand	MMCMD	1.19	1.69	2.26

Gas demand projections for the industrial sector is summarised in the Table below.

Table 6.6 Gas demand from industries

	2006		2011	
Industries	MMCMD	Million tonnes	MMCMD	Million tonnes
Cement	3.74	0.94	5.01	1.25
Paper and pulp	2.90	0.73	3.89	0.97
Glass	1.69	0.42	2.26	0.57
Total	8.33	2.08	11.16	2.79

Comments on the demand estimate

In the above analysis we have left out the textile and chemical units in the absence of reliable data. The cement industry, which has the potential of using the largest amount of gas, does not use any gas at present. Only the very large, modern units can change to gas. Even that would require efforts in introducing the technology.

Gas could be used more efficiently than alternative fuels are at present. This means equating the calorie values would overestimate the gas demand.

Unlike cement units, paper and glass units in India are already using gas but improved technology is required if these units have to use costlier imported gas.

Up to date information on industrial units is hard to come by. The gas demand from industrial units can be much better estimated through field surveys, once the approximate pipeline route is decided on.

Creditworthiness of demand

Only the large and modern units will come forward to take expensive LNG-gas and these units are expected to be creditworthy. However, this has to be established individually.

7

Estimation of gas demand - captive power

Gas demand for captive generation

The need for captive power generation has increased over the years. The dependence on captive power generation is the highest in the industrial sector and the main contributing factors have been the following:

- Non-availability of adequate grid supply
- Poor quality and reliability of grid supply
- High tariff as a result of heavy cross-subsidization.

Policy on captive generation

Captive capacity deprives the utilities from revenue from the sale of power. This is all the more important because non-industrial tariffs are lower than the cost of supply. Many state governments have, therefore, discouraged captive capacity. However, it has been difficult to maintain such a stand in the face of growing power shortages. The other factor favouring captive capacity is the possibility of using renewable sources like wind energy. The central government has recently released a policy on captive power exhorting the states to encourage captive generation.

The Gujarat Electricity Board formulated its captive power policy in November 1998. The state has been encouraging the setting up of captive plants with a view to reducing the burden on GEB. Captive plant owners are allowed to sell surplus power to only their group companies. The state allows wheeling of power to other industrial units within the same company or group of companies, subject to certain conditions.

The Madhya Pradesh Electricity Board announced its captive power policy in June 1996. Ammendments to this policy were made in November 1996 and January 1998. Captive plants can be set up only by HT consumers of the Board. Third party sales by captive plant owners are permitted. The captive plant owner is allowed to wheel surplus power through MPEB's grid lines to its own HT connection or any other HT consumers, within the state.

The Uttar Pradesh Electricity Regulatory Commission (UPERC) is encouraging captive power generation in the state with a view to providing reliable and quality power to industries in UP and bridging the gap between demand and supply of power in general and at peak in particular. However, the option of captive power generation is being looked at as a short-term solution only. The government is of the view that the long-term solution lies in privatization of the distribution sector. Captive plant owners are allowed to sell to other industrial units within a radius of 5 km by installing their own transmission and distribution lines.

Punjab State Electricity Board has identified the load centres where industrial units can set up captive power plants. They can set up these plants on their own or with help from independent power producers. The electricity generated can either be consumed by the captive plant owner himself or sold to a group of large HT consumers on captive basis. The captive plant owner is allowed to directly negotiate the tariff with the consumers.

The Haryana Electricity Board has moved from a restrictive captive power policy towards a more liberal captive policy. Two primary relaxations were made in 1999. First, the ceiling on capacity for industrial units to set up captive plants was raised from 200% of their connected or applied-for load to 300%. Secondly, even units, which are not consumers of grid power are also made eligible to apply for setting up captive plants. Also, captive power plants based on non-conventional sources are exempt from sales tax or purchase tax.

There is no captive generation in Delhi. Delhi does not have a captive power policy and the Supreme Court had ruled against installation of captive power plants.

The Rajasthan Government has formulated a Revised Captive Power Plant Policy for creating an institutional mechanism for providing an easy and automatic entry for industry to meet its requirement of energy by setting up its own generating stations. Regarding the issue of third party sales (TPS), 65% of power generated can be sold to group of industries.

The state governments and state electricity boards have also taken policy initiatives in allowing joint captive plants, third-party sales, wheeling and banking, sale of surplus power to SEBs and stand-by sales.

Installed captive capacity

Captive capacity is not reported by either the State Electricity Boards or the Central Electricity Authority. Data is available only for 1997-98 and 1998-99, compiled by Powerline Research. The publisher has explained that it is not a complete compilation and that it is based on data made available by the SEBs. The publisher estimates that unreported captive capacity could amount to as much as 40% of the capacity reported. According to Powerline Research, the fuelwise break up of captive capacities in the concerned states is as shown in the Tables below.

Table 7.1 Captive capacity by fuel type in 1997-98 (MW)

States	Gas/Naphtha	Diesel	Steam	Total
Gujarat	965	149	391	1505
Madhya Pradesh	11	579	742	1333
Uttar Pradesh	296	90	854	1240
Punjab	0	249	62	311
Haryana	60	206	70	335
Rajasthan	46	345	138	528
Total	1378	1618	2257	5252

Source. 1999 Captive Report (Powerline)

Table 7.2 Captive capacity by fuel type in 1998-99 (MW)

States	Gas/Naphtha	Diesel	Steam	Other	Total
Gujarat	1076	256	428	90	1850
Madhya Pradesh	11	680	800	4	1495
Uttar Pradesh	296	124	854	0	1275
Punjab	0	419	76	0	495
Haryana	60	214	69	0	343
Rajasthan	46	356	162	9	573
Total	1489	2049	2389	103	6031

Source. 1999 Captive Report (Powerline)

The industrywise break-up of the installed capacity is as below.

Table 7.3 Captive capacity by state by industry in 1998-99 (MW)

Industry	Gujarat	Madhya Pradesh	Uttar Pradesh	Punjab	Haryana	Rajasthan	Total
Cement	122	304	1	4	16	191	638
Chemicals	800	38	290	93	39	61	1321
Electronics	0	8	3	4	2	3	20
Engineering	53	631	26	75	127	27	939
Jute	0	22	0	0	0	0	22
Minerals and metals	197	19	715	0	75	92	1098
Miscellaneous	45	96	28	52	56	44	321
Paper	26	49	38	11	3	16	143
Services	0	17	0	0	0	2	19
Sugar	88	14	127	91	17	0	337
Textile	472	287	10	158	8	125	1060
Unclassified	49	11	38	6	0	11	115
Total	1850	1495	1275	495	343	573	6031

Source. 1999 Captive Report (Powerline)

Trends and projections in captive generation

The 16th EPS gives the trends in captive generation over the last few years. The table below shows the figures for statewise captive generation over the years 1993-99.

Table 7.4 Captive generation (million kWh)

States	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99*	Growth rate (%) [illegible]
Gujarat	3458	3684	4543	4873	5025	6397	13.09
Madhya Pradesh	3303	3394	3942	4184	4645	4689	7.26
Uttar Pradesh	3669	4224	4229	4542	5271	5686	9.15
Punjab	266	284	336	370	373	375	7.09
Haryana	666	684	802	832	833	834	4.58
Delhi	143	156	140	92	92	93	-9.00
Rajasthan	720	907	1165	1401	1351	1412	14.41
Total	12082	13177	15017	16202	17499	19393	

*Estimated

Source. 16th Electric Power Survey

Captive generation has grown rapidly in Rajasthan and Gujarat and more slowly in the other states. Industrial consumers account for most of the captive generation. The growth rate in industrial production and the price paid by industrial consumers to the utilities are the key determinants of growth in captive generation in future. In projecting the growth in captive generation, we should therefore think of a high reform and a low reform scenario as done in the case of power and urea production.

The 16th Electric Power Survey projects the growth in captive generation as presented in the Table below.

Table 7.5 Projected captive generation (MW)

States	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	Growth Rate (%) 1998/9-2004/5
Gujarat	6766	6986	7243	7473	7703	7927	3.64
Madhya Pradesh	4891	4938	4969	5015	5041	5079	1.34
Uttar Pradesh	6141	7182	7343	7983	8017	8050	5.97
Punjab	381	392	565	577	589	601	8.18
Haryana	835	874	1068	1104	1141	1178	5.92
Delhi	100	106	112	118	124	130	5.74
Rajasthan	1423	1453	1483	1513	1543	1573	1.82
Total	20537	21931	22783	23783	24158	24538	-

Source. 16th Electric Power Survey

It may be seen that sharp decreases have been projected for Gujarat, Madhya Pradesh and Rajasthan. These reductions are possible in the high reform scenario. As reforms progress, the cross subsidy in tariffs would be removed faster resulting in reduced tariff for the industrial consumer. This would increase the use of grid power by industry and reduce dependence on captive generation. In the low reform scenario, it would be unrealistic to assume a sharp drop in captive generation. In this case we assume that the rates of growth would be 10% for Gujarat and Rajasthan and 5% for Madhya Pradesh. For the other states, the rates remain the same as in 16th EPS.

Table 7.6 Projected growth rates (%)

States	High reforms scenario (16th EPS)	Low reforms scenario
Gujarat	3.64	10.00
Madhya Pradesh	1.34	5.00
Uttar Pradesh	5.97	5.97
Punjab	8.18	8.18
Haryana	5.92	5.92
Delhi	5.74	5.74
Rajasthan	1.82	10.00

Potential gas demand

Assumptions

It has been assumed that captive gas based generators would operate as open cycle plants with an efficiency of 35%.

Captive generation based on coal and diesel is not convertible to gas. Thus, it is assumed that only naphtha based capacity will be available for conversion to gas in 2006/07. For projecting the gas demand from conversion, the share of naphtha in captive generation is assumed to remain constant till 2006/07 and it is assumed that one-third of naphtha based plants would change to gas. The conversion demands have been computed for both the high reform and the low reform scenarios. In 2006/7, this will be the only demand.

In 2011/12, there would be another component in the demand coming from the growth in captive generation between 2006/7 and 2011/12. Once again we assume that one-third of the growth would be gas based.

With these assumptions, the gas demand works out as below:

Table 7.7 Gas demand for captive generation - high reforms

	2006/07		2011/12	
States	MMCMD	Million tonnes	MMCMD	Million tonnes
Gujarat	1.24	0.31	1.67	0.42
Madhya Pradesh	0.01	0	0.10	0.03
Uttar Pradesh	0.53	0.13	1.30	0.32
Punjab	0	0	0.09	0.02
Haryana	0.06	0.02	0.17	0.04
Delhi	0	0	0.07	0.02
Rajasthan	0.03	0.01	0.01	0.00
Total	1.87	0.47	3.40	0.85

Table 7.8 Gas demand for captive generation - low reforms

	2006/07		2011/12	
States	MMCMD	Million tonnes	MMCMD	Million tonnes
Gujarat	2.01	0.50	4.12	1.03
Madhya Pradesh	0.01	0.00	0.50	0.12
Uttar Pradesh	0.53	0.13	1.30	0.32
Punjab	0.00	-	0.09	0.02
Haryana	0.06	0.01	0.17	0.04
Delhi	0.06	-	0.53	0.13
Rajasthan	0.00	0.00	0.01	0.00
Total	2.67	0.67	6.71	1.68

8

Estimation of gas demand - city distribution

Urban agglomerations

Within the seven states under study, gas is used as a domestic fuel only in Delhi, Vadodara, Surat and Ankleshwar. As noted earlier, the use of natural gas as a household fuel in India is limited. Gas is used only for cooking and there is no space heating. A household consumes only 1 cubic metre of gas per day. Accordingly, a viable project could not be based only on domestic demand. It has to be supported by a strong component of demand from industrial and commercial units.

The proportion of urban population in these states is given in the Table below.

Table 8.1 Urban population (%) in 1991

States	Population (%)
Gujarat	34.5
Madhya Pradesh	23.2
Uttar Pradesh	19.8
Punjab	29.5
Haryana	22.9
Delhi	89.9
Rajasthan	22.9

Source. Census 1991

Although urbanization is high, the number of large cities is limited. The cities with population above one million are shown in Map 8.1. The particulars are in the Table below.

Table 8.2 Cities with population exceeding 1 million

Urban agglomerations	District	Population (million) 1991	2006/07	2011/12
Gujarat				
Ahmedabad	Ahmedabad	3.30	5.26	6.14
Surat	Surat	1.52	2.42	2.82
Vadodara	Vadodara	1.12	1.78	2.08
Rajkot	Rajkot	0.65	1.04	1.21
Madhya Pradesh				
Indore	Indore	1.10	1.76	2.05
Bhopal	Bhopal	1.06	1.70	1.98
Jabalpur	Jabalpur	0.89	1.41	1.65
Gwalior	Gwalior	0.72	1.15	1.34
Durg Bhilainagar	Durg	0.69	1.10	1.28
Uttar Pradesh				
Kanpur	Kanpur Nagar	2.11	3.37	3.93
Lucknow	Lucknow	1.64	2.62	3.06
Varanasi	Varanasi	1.03	1.64	1.91
Agra	Agra	0.96	1.52	1.78
Allahabad	Allahabad	0.86	1.37	1.60
Meerut	Meerut	0.85	1.35	1.58
Bareilly	Bareilly	0.61	0.97	1.13
Punjab				
Ludhiana	Ludhiana	1.01	1.61	1.88
Amritsar	Amritsar	0.71	1.13	1.32
Haryana	Faridabad	0.61	0.98	1.14
Delhi		8.38	13.35	15.59
Rajasthan				
Jaipur	Jaipur	1.51	2.41	2.82
Jodhpur	Jodhpur	0.65	1.03	1.21

Source. Census 1991

Potential gas demand

We have projected gas demand only for large cities/urban agglomerations, which have population in excess of 2 million. This cut-off has been chosen arbitrarily and it is not certain that distribution projects would be viable in all these cities. The 2001 Census gives provisional population data at the state level only. Population figures for urban agglomerations are not available. Thus, the 1991 Census figures have been used for projecting the population. The growth estimates as given by demographer Ashish Bose have been used (Table 8.3).

These growth rates are averaged over all the urban agglomerations in India. They include contributions both from birth and migration.

Table 8.3 Projected growth rates

Penod	Growth rate (%)
1991-2001	3.16
2001-2011	3.15

Source. Prof. A Bose

Five people per household has been considered for computing the number of households. The coverage of households by LPG would increase in future as incomes rise and the availability of LPG improves. A survey conducted recently on behalf of the oil companies indicates that the coverage of LPG would increase as follows:

- 55% in 2006/07
- 65% in 2011/12

LPG has been used in the country since the 1960s and the fuel has established widespread acceptability. It will not be easy for gas to replace LPG. The experience of Delhi and Mumbai shows that natural gas can compete with LPG only if it is supplied at a substantial price differential. Based on the experience in these projects, it is expected that the penetration of natural gas into households using LPG would be 40% in 2006/07 and 50% in 2011/12.

Assuming the consumption of 1 cubic metre of gas per household per day, the gas demand for city distribution comes out to be 1.29 MMCMD in 2006/07 and 2.5 MMCMD in 2011/12. The statewise break up of demand is given in the Table below.

Table 8.4 Gas demand for city distribution

	2006/07		2011/12	
State	MMCMD	Million tonnes	MMCMD	Million tonnes
Gujarat	0.34	0.09	0.72	0.18
Madhya Pradesh	0	0	0.13	0.03
Uttar Pradesh	0.26	0.07	0.45	0.11
Punjab	0	0	0	0
Haryana	0	0	0	0
Delhi	0.59	0.15	1.01	0.25
Rajasthan	0.11	0.03	0.18	0.05
Total	1.29	0.32	2.50	0.63

9

Imputed values

Methodology

The imputed value of gas is the price of gas at which the cost of generation or production in a gas based plant equals the cost of generation/production using an alternative fuel, at a particular location. Thus it indicates the maximum price for gas at which it is competitive with the cheapest alternative fuel. The methodology used has been illustrated in Table below.

Table 9.1 Methodology for calculating imputed value of gas

Cost of generation/production	Gas based	Competing technology
Capital cost	a	c
Operation and maintenance cost	b	d
Fuel cost	X (unknown)	e
Total cost		f = c + d + e
Imputed value of gas		X = f - a - b

Power generation

Domestic coal occupies the largest share in total installed capacity in India. The use of imported coal for power generation is also increasing. Additionally, to improve the quality of domestic coal, washing and blending are being practiced. Thus, imputed values of gas have been calculated against domestic coal, imported coal, washed domestic coal and blended coal. The locations for calculating imputed values are given in the Table below. These locations have been proposed for gas based and coal based power plants in the XIth Five Year Plan period (2007-12).

Table 9.2 Locations for imputed values in power generation

State	Location
Delhi	Bawana
Haryana	Faridabad, Hissar
Punjab	Doraha, Bathinda, Govindwal
Rajasthan	Dholpur, Suratgarh, Anta, Raigarh
Uttar Pradesh	Auraiya, Unchahar, Rosa, Jawaharpur, Partapur
Gujarat	Kawas, Ghandhar, Mundra, Pipavav
Madhya Pradesh	Bhander, Sipat, Korba

Capital cost per unit of power, including interest during construction (IDC) are annuitised using the capital recovery factor which is determined by the operating life of the project and the discount/interest rates. Annual generation, determined by the plant load factor (PLF) minus the auxiliary consumption gives the net units sent out in a year. These together provide the capital cost per unit of electricity sent out which along with the O&M costs and the fuel costs per unit give the total cost of generation of a unit of electricity sent out.

Fuel costs

Imported coal

The cif price of steam coal imported into Japan has varied within the band of $40-50 /MT over 1987-1999 (Figure 1).

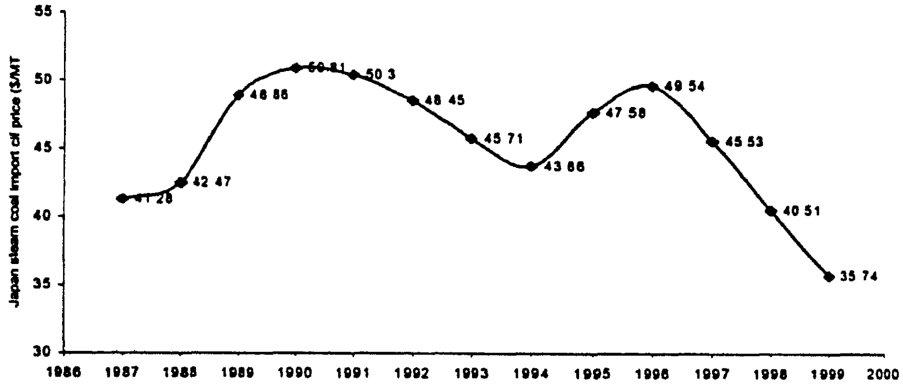

Figure 9.1 Trends in long term coal prices: Japan steam coal cif price ($/MT)
Source. BP Amoco alive 2000

The price dipped below $40/MT for the first time in 1999. In April and May, 2001 it was $39 and $38 per tonne. Indian cif prices have been close to the Japanese cif prices. Two values of cif prices of imported coal have been taken for this study: $35/MT and $40/MT.

Kandla, Dahej, Mundra and Pipavav, ports in Gujarat, have been taken as the landing ports for imported coal or liquid fuels. The landed cost of coal is shown in Annexure 9.1.

The railway freight from port to the power plant location has been taken as per the Indian Railway Conference Association: Goods Tariff No. 43. No escalation in freight for future years has been considered. The landed cost and transportation costs together give the delivered costs of imported coal at the locations considered. These are given in Annexure 9.2.

Indigenous coal

Supply of power grade coal to power plant locations has been considered from Korba fields in Madhya Pradesh keeping in view the future availability of coal.

Indigenous coal prices have been decontrolled from January 2000. These prices are now determined by Coal India Limited (CIL). No indications from CIL are available on how the prices will move in future.

The current power grade coal price (without taxes) from Korba is Rs 497/MT. Rs. 50/MT of royalty, Rs. 41 for sizing and internal transport, Rs. 3.50/MT of excise and 4% CST have been added to the pithead cost to arrive at the price of coal from Korba. Estimates of coal washing charges range from Rs 150-300/MT. We have taken Rs 150/MT as the long term washing charges. Transportation costs are added to arrive at the final price of domestic coal at various power plant locations. The price build up is shown in Annexure 9.3.

Technical and financial parameters

Imported coal has a higher calorific value (6400 kcal/kg) than domestic power grade coal (4000 kcal/kg) but imported coal has a greater sulphur content. Coal washing (Rs 150/MT) also improves the calorific value of domestic coal, which is taken as 4482 kcal/kg. Blending 76% domestic coal with 24% imported coal reduces the ash content to the stipulated 34% and this is an alternative to washed coal. However, a plant based on imported coal will be required to install a flue gas desulphurisation unit at a 10% additional capital cost.

Till date India has operated only subcritical coal based power plants. However, NTPC plans a 660 MW supercritical coal power plant at Seepat by 2006-07. Hence, in this analysis subcritical as well as supercritical coal power plants have been considered. A typical subcritical coal based power plant has an efficiency of about 37% compared to 39.1% for a supercritical coal based power plant. The efficiency of an advanced combined cycle gas based power plant has been taken as 56%. The technical and financial parameters of subcritical coal based plants, supercritical coal based plants and advanced class combined cycle gas turbines are given in Tables below.

Table 9.3 Technical and financial parameters for subcritical coal based plants

Technical parameters	Units	Value
Plant load factor	%	75
Auxiliary consumption (indigenous coal)	%	8.0
Auxiliary consumption (imported coal)	%	8.5
Life of plant	Years	30
Calorific value (indigenous coal)	kcal/kg	4000
Calorific value (imported coal)	kcal/kg	6400
Calorific value (washed coal)	kcal/kg	4482
Calorific value (blended coal)	kcal/kg	4576
Heat rate per unit sent out (indigenous coal)	kcal/kWh	2526
Heat rate per unit sent out (imported coal)	kcal/kWh	2540
Financial parameters		
Discount rate	%	12
Capital cost per MW (indigenous coal based)	Rs. Million	40
Capital cost per MW (imported coal based)	Rs. Million	44
Fixed operation cost as % of capital cost	%	2.5
Investment period	Years	4

Table 9.4 Technical and financial parameters for supercritical coal based plants

Technical parameters	Units	Value
Plant load factor	%	75
Auxiliary consumption (indigenous coal)	%	8.5
Auxiliary consumption (imported coal)	%	9.0
Life of plant	Years	30
Calorific value (indigenous coal)	kcal/kg	4000
Calorific value (imported coal)	kcal/kg	6400
Calorific value (washed coal)	kcal/kg	4482
Calorific value (blended coal)	kcal/kg	4576
Heat rate per unit sent out (indigenous coal)	kcal/kWh	2404
Heat rate per unit sent out (imported coal)	kcal/kWh	2417
Financial parameters		
Discount rate	%	12
Capital cost per MW (indigenous coal based)	Rs. Million	40
Capital cost per MW (imported coal based)	Rs. Million	44
Fixed operation cost as % of capital cost	%	2.5
Investment period	Years	4

Table 9.5 Technical and financial parameters for advanced class combined cycle gas turbines

Technical parameters	Units	Value
Plant load factor	%	80
Auxiliary consumption	%	3
Life of plant	Years	30
Calorific value	kcal/Nm^3	8500
Heat rate per unit sent out	kcal/kWh	1583
Financial parameters		
Discount rate	%	12
Capital cost per MW	Rs. Million	30
Fixed operation cost as % of capital cost	%	2.0
Investment period	Years	3

Imputed values of gas in power generation

The imputed values at the selected power plant locations have been given in Table 9.6 for subcritical coal based plants and in Table 9.7 for supercritical coal based plants. The detailed calculations are at Annexure 9.3.1 to 9.3.44. At all the locations, imputed values of gas are lower for washed coal as compared to blended coal. Map 9.1 shows the imputed values for the different locations.

Table 9.6 Imputed values of gas in power generation (subcritical)

	Imputed values of gas				
Location	Domestic coal with washing	Domestic coal without washing	Imported coal \$35/MT	Imported coal \$40/MT	Blended coal
Dholpur	4.53	4.56	6.46	6.84	5.63
Doraha	5.16	5.27	6.52	6.91	6.13
Faridabad	4.80	4.86	6.27	6.65	5.77
Hisar	5.13	5.23	6.37	6.75	6.05
Auraiya	4.56	4.60	6.81	7.19	5.77
Bhander	4.46	4.47	6.41	6.79	5.56
Bhawana	4.87	4.94	6.32	6.70	5.84
Kawas	5.16	5.27	5.20	5.58	5.68
Ghandhar	5.08	5.17	5.20	5.58	5.62
Bhatinda	5.45	5.58	6.72	7.11	6.41
Suratgarh	5.59	5.75	6.29	6.68	6.37
Anta	4.56	4.60	6.00	6.38	5.50
Unchahar	4.31	4.31	6.62	7.00	5.52
Rosa	4.95	5.03	6.74	7.12	6.04
Sipat	3.28	3.16	6.67	7.05	4.77
Korba	3.08	2.93	6.72	7.11	4.63
Jawaharpur	4.64	4.68	6.52	6.91	5.73
Partapur	5.41	5.55	6.38	6.77	6.27
Mundra	5.16	5.27	5.06	5.44	5.63

	Imputed values of gas				
Pipavav	5.51	5.66	5.06	5.44	5.89
Raigarh	3.33	3.21	6.74	7.12	4.83
Govindwal	5.22	5.33	6.56	6.94	6.18

Table 9.7 Imputed values of gas in power generation (supercritical)

	Imputed values of gas				
Location	Domestic coal with washing	Domestic coal without washing	Imported coal $35/MT	Imported coal $40/MT	Blended coal
Dholpur	4.41	4.44	6.27	6.64	5.48
Doraha	5.01	5.11	6.33	6.69	5.95
Fandabad	4.67	4.72	6.09	6.45	5.61
Hisar	4.98	5.07	6.19	6.55	5.88
Auraiya	4.44	4.47	6.60	6.97	5.62
Bhander	4.34	4.36	6.22	6.59	5.41
Bhawana	4.74	4.80	6.14	6.50	5.68
Kawas	5.01	5.11	5.07	5.43	5.53
Ghandhar	4.93	5.02	5.07	5.43	5.47
Bhatinda	5.28	5.41	6.52	6.89	6.22
Suratgarh	5.42	5.57	6.11	6.48	6.18
Anta	4.44	4.47	5.83	6.20	5.36
Unchahar	4.20	4.20	6.42	6.79	5.37
Rosa	4.81	4.88	6.54	6.90	5.87
Sipat	3.22	3.11	6.47	6.84	4.66
Korba	3.03	2.89	6.52	6.89	4.53
Jawaharpur	4.51	4.55	6.33	6.69	5.58
Partapur	5.25	5.38	6.20	6.56	6.09
Mundra	5.01	5.11	4.93	5.30	5.48
Pipavav	5.34	5.48	4.93	5.30	5.73
Raigarh	3.27	3.16	6.54	6.90	4.72
Govindwal	5.07	5.17	6.37	6.73	6.00

Urea production

Imputed values of gas in urea production have been calculated at the locations as given in the Table below. Imputed values have been estimated against imported urea and naphtha at import parity prices as well as export parity prices. The imputed value against the urea price of Rs 7500/MT recommended by the Expenditure Reforms Commission has also been computed.

Table 9.8 Locations for imputed values in urea production

State	Location
Rajasthan	Kota
Uttar Pradesh	Panki, Gorakhpur, Shahjahanpur, Phulpur, Aonla, Jagdishpur, Babrala, Auraiya
Gujarat	Vadodara, Kalol, Hazira

Currently, there is no import duty on urea. However, imputed values have been calculated under three scenarios: zero, 10% and 25% import duty.

Technical and financial parameters

The technical and financial parameters of gas based urea plants as given in the Table below conform to the assumptions of the High Powered Committee on Fertilizer Pricing Policy. The capital cost of new a gas based urea plant is Rs 17,000 million and that of a new naphtha based plant is Rs. 17,500 million. The capital cost of a urea plant converting from naphtha to gas has been taken at a depreciated value of Rs 8,750 million. The technical and financial parameters of a naphtha based urea plant are listed in the Table below.

Table 9.9 Technical and financial parameters of a typical gas based urea plant

Parameter	Unit	Value
Technical		
Urea capacity	Tons/year	726,000
Energy required per ton of urea	Gcal/ton	5.40
Calorific value of gas	Kcal/Nm^3	8500
Life of plant	Years	15
Financial		
Discount rate	%	12
Capital cost (new plant)	Rs. Million	17,000
Capital cost (expansion plan)	Rs. Million	15,000
Fixed operating cost	Rs/ton	854
Investment period	Years	3

Table 9.10 Technical and financial parameters of a typical naphtha based urea plant

Parameter	Unit	Value
Technical		
Urea capacity	Tons/year	726,000
Energy required per ton of urea	Gcal/ton	5.10
Calorific value of gas	Kcal/Nm^3	10560
Life of plant	Years	15

Parameter	Unit	Value
Financial		
Discount rate	%	12
Capital cost (new plant)	Rs. Million	17,500
Fixed operating cost	Rs/ton	924
Investment period	Years	3

Price of urea

The cif price of imported urea has fluctuated widely in the past depending critically on purchases made by India and China. The international urea prices from 1971 to 1998 are given in Table 9.11.

Table 9.11 International urea price at current price

Year	Price at current $ (per MT)	Year	Price at current $ (per MT)	Year	Price at current $ (per MT)
1971	46.00	1980	222.10	1989	132.20
1972	59.30	1981	216.00	1990	157.00
1973	94.80	1982	158.80	1991	172.00
1974	315.80	1983	135.40	1992	140.30
1975	198.00	1984	171.30	1993	106.75
1976	112.00	1985	136.30	1994	147.92
1977	127.40	1986	107.00	1995	211.50
1978	144.80	1987	116.60	1996	205.48
1979	172.90	1988	155.00	1997	103.00
				1998	91.00

Source. EPW July 1999

A cif price of $150/MT is taken as the average. The landed cost of imported urea at the Indian port with a cif price of $ 150/MT, an exchange rate of Rs 46 per US dollar and no duty is Rs 6900/MT. The landed cost at the India port would be Rs 7590/MT and Rs 8625/MT if we assume an import duty of 10% and 25%, respectively.

Imputed values of gas in urea production

Imputed values of gas against urea imports under three scenarios (zero, 10% and 25% import duty) are given in Table 9.12. Detailed calculations have been presented in Annexures 9.4-9.6. Map 9.2 shows the imputed values at different locations.

Table 9.12 Imputed values of gas against urea imports at cif $150/MT

Location	Imputed values ($/MMBtu): New plants			Imputed values ($/MMBtu): Expansion		
Import duty	zero	10%	25%	zero	10%	25%
Kota	2.52	3.22	4.27	3.01	3.71	4.76
Panki	2.83	3.53	4.58	3.32	4.02	5.07
Gorakhpur	2.95	3.65	4.70	3.43	4.13	5.18
Shahjahanpur	2.96	3.66	4.71	3.44	4.14	5.19
Vadodara	2.27	2.97	4.02	2.75	3.45	4.50
Kalol	2.22	2.92	3.97	2.70	3.40	4.45
Phulpur	2.90	3.60	4.65	3.38	4.08	5.13
Aonla	2.80	3.50	4.55	3.28	3.98	5.03
Jagdishpur	2.90	3.60	4.65	3.38	4.08	5.13
Hazira	2.31	3.01	4.06	2.79	3.49	4.54
Babrala	2.76	3.46	4.51	3.24	3.94	4.99
Auraiya	2.86	3.56	4.61	3.34	4.04	5.09

The Expenditure Reforms Commission has recommended Rs 1,900/MT to be allowed as concession to new units based on LNG while the farmgate price paid by the consumer is pegged at Rs 7000/ MT. In that case, the producer would receive a net price of Rs. 8,600/MT after deducting Rs 300/ MT as the marketing cost. The imputed value of gas against this producer price is $ 4.24/MMBtu for an expansion of a gas based plant and $4.85/MMBtu for conversion of naphtha based plant to a gas based plant. Expansions of gas based urea plants have been considered at four locations: Hazira, Jagdishpur, Shahjahanpur and Babrala. The possibility of conversion of naphtha based plant to a gas based plant is taken at five locations: Kota, Panki, Gorakhpur, Vadodara and Phulpur. Details of imputed values against a producer price of Rs 8,600/MT are presented at Annexure 9.7.

The existing gas based urea plants will be facing deficits in the supply of domestic gas in 2006/7 and 2011/12. To calculate the imputed values in these cases, we have assumed an ex-plant urea price of Rs 8,600/MT and also that the plants are depreciated to half the cost of a new plant. The calculation is at Annexure 9.7.1.

LNG vs Naphtha

Any urea producer wishing to change over to LNG would have to enter into a long-term contact (15-20 years) with LNG suppliers. In a situation of naphtha surplus in the country, the question remains if future naphtha prices could drop to such low levels as to become competitive with the LNG option. If such were the case, urea producers should stay with naphtha rather than opting for LNG.

To examine such possibility, we have calculated naphtha export parity prices at three locations: Kota, Panki and Phulpur. At each location, naphtha prices have been calculated corresponding to 18 $/bbl, 22 $/bbl and 28 $/bbl Middle East crude oil prices. The fob-Middle East naphtha prices have been regressed against fob-Middle East crude oil prices over March 1996 to June 2000. Transportation charges of 10$/MT have been added to arrive at naphtha prices at Kandla port. Refinery gate prices at Mathura are obtained by deducting 46.4 $/MT as the freight from port to refinery. Finally, naphtha export parity prices at Kota, Panki and Phulpur are arrived at by adding inland transportation. These are presented in the Table below. For comparison, naphtha import parity prices have also been presented. Detailed calculation of export parity and import parity prices are given in Annexures 9.8-9.11. There are no customs and countervailing duty for naphtha imports in the fertilizer industry.

Table 9.13 Naphtha export parity and import parity price

Locations	Arab Gulf crude price ($/bbl)	Naphtha export parity price ($/MT)	Naphtha import parity price ($/MT)
Kota	18	164	244
	22	200	281
	28	255	337
Panki	18	162	255
	22	198	293
	28	253	349
Phulpur	18	171	249
	22	208	286
	28	263	342

The imputed values of gas against the above naphtha prices at Kota, Panki and Phulpur are presented in the Table below. Details of the calculations are presented in Annexures 9.12 to 9.17.

Table 9.14 Imputed values of gas against naphtha

Locations	Arab Gulf crude price ($/bbl)	Imputed value against naphtha export parity price ($/MMBtu)	Imputed value against naphtha import parity price ($/MMBtu)
Kota	18	3.88	5.69
	22	4.70	6.54
	28	5.94	7.80
Panki	18	3.83	5.94
	22	4.66	6.79
	28	5.90	8.05
Phulpur	18	4.05	5.80
	22	4.87	6.64
	28	4.11	7.91

Industries, captive and city distribution

Imputed values for cement and paper industry have been calculated at three locations, Sikka in Gujarat, Kota in Rajasthan and Delhi, against domestic coal. For glass industry and city distribution. imputed values have been calculated against LPG ex-Koyali and ex-Mathura. For captive generation, imputed values have been calculated against naphtha ex-Koyali and ex-Mathura. Here the naphtha price is at import parity. If we add the transport cost of LPG and naphtha from the refinery to the actual locations, the imputed values would be even larger.

Fuel costs

LPG and Naphtha

These fuels are priced on import parity basis. The fob-Middle East LPG prices have been regressed against fob-Middle East crude oil prices over January 1996 to September 1999. The fob-Middle East naphtha prices have also been regressed against fob-Middle East crude oil prices over March 1996 to June 2000.

The insurance, sea freight charges, import duties and port storage and handling charges are added to the fob price to derive the landed cost of LPG and naphtha at Kandla and Mumbai ports. The customs and countervailing duty conform to the Expert Technical Group recommendations accepted by the government. The details of landed cost for LPG and naphtha have been shown in Annexures 9.18 to 9.19.

Domestic coal

Average calorific value of domestic coal for industrial use is assumed to be 4,800 kcal/kg. Supplies from Korba coalfield in Madhya Pradesh have been considered. The price of D grade coal from Korba field is Rs 750/MT. Royalty of Rs 70/MT, Rs 3.50/MT of excise and 4% CST has been added to get the final price at Korba. Transportation costs and delivered prices of domestic coal from Korba to Sikka, Kota and Delhi are shown in Annexure 9.20.

Imputed values of gas in industries, captive, and city distribution

Imputed values of gas for industries, captive generation and city distribution have been computed on calorie equivalence. The Table below presents the imputed values. The details are at Annexures 9.21 to 9.23.

Table 9.15 Imputed values for industries, captive generation and city distribution

Location	Imputed values ($/MMBtu)
Cement and paper industry: against domestic coal	
Sikka	2.39
Kota	1.83
Delhi	2.03
Glass industry and city distribution: against LPG	
Ex-Koyali	7.44
Ex-Mathura	7.96
Captive generation: against naphtha	
Ex-Koyali	6.67
Ex-Mathura	6.25

Industry in Gujarat is now paying a gas price of Rs 2850/thousand cubic metres which equals $1.56/MMBtu. In addition they pay royalty of 10% ($0.16/MMBtu) and transport charges depending on location. The domestic gas price is due for a revision and may soon exceed $3/MMBtu. The consumers will not surrender their allocations and change to coal. Indications are that most of them would continue to use gas. The imputed values of $1.83 - 2.39/MMBtu calculated for industrial units, therefore, underestimates the price they would be willing to pay. It is possible for cement units to reduce energy consumption from 930 kcals/kg, assumed by us in computing the imputed value, to 700 kcals/kg. There are additional benefits in terms of savings in power consumption, refractory consumption and clinker quality in changing over to gas. Cement producers should be able to pay between $2.9–3.6 / MMBtu depending on location.

How firm are the imputed values?

- There are many uncertainties in the calculation of the imputed values which are expected to be exploited by both sides during price negotiations. The principal difference in the imputed values for power and fertilizers is likely to be over efficiencies.
- For the power sector we have adopted 56% efficiency of gas turbines. Many power producers in India are more comfortable with 52% efficiency although 56% is now being guaranteed for India. This may lead to a difference of around 30 cents / MMBtu in the imputed values.
- For gas based urea production we assume that 5.4 Gcals are required for 1 MT of urea, whereas most urea producers favour 6 Gcals / MT of urea. This leads to a reduction of 40 cents / MMBtu in the imputed value of $4.2 / MMBtu computed by us for expansion units. There is a similar difference for units converting from naphtha to gas.

10

Profile of gas demand

Time profile of gas demand

Putting together the several components of potential gas demand we get the following time profile.

Table 10.1 Demand -supply of gas (million tonnes)

Demand / supply		2001/2	2006/7	2011/12
Demand	High reforms	14.76	24.37	29.78
	Low reforms	14.76	20.36	26.55
Supply	Gujarat-ONGC	1.52	0.73	0.17
	Gujarat-non-ONGC	0.08	1.25[a]	2.00[b]
	Western-offshore	9.19	10.93[c]	8.07[d]
	Total	**10.78**	**12.91**	**10.24**
Deficit	High reforms	3.97	11.46	19.54
	Low reforms	3.97	7.45	16.31

[a] Includes 0.75 mt from Hazira field of GSPCL and 0.50 mt from offshore field of Cairns Energy. The production is scheduled to reach 1.0 mt by 2003 and 1.25 mt by 2004;

[b] Includes 1.0 mt each from GSPCL and Cairns. Output from Cairns could go up to 2.0 mt;

[c] Includes a production of 0.37 mt from anticipated reserves;

[d] Includes a production of 1.25 mt from anticipated reserves

The time profile and the price profiles of the incremental gas demand to be met by imports would be as below.

Table 10.2 Sector-wise incremental gas demand

Scenarios	Power	Urea	Industries	City distribution	Captive generation	Existing consumers	Total (MMCMD)	Total (mt)
High reforms								
2006/7	20.41	6.92	8.33	1.29	1.88	7.38	46.21	11.55
2011/12	28.61	14.42	11.16	2.50	3.40	18.06	78.15	19.54
Low reforms								
2006/7	10.45	6.92	8.33	1.29	2.67	7.38	37.04	9.26
2011/12	16.89	9.92	11.16	2.50	6.71	18.06	65.24	16.31

The total demands (MMCMD) in the two scenarios are plotted below.

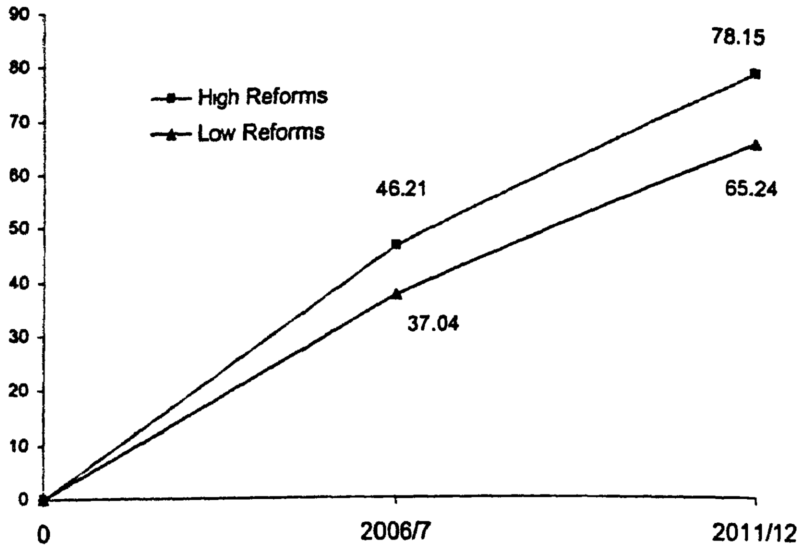

Figure 10.1 Total potential gas demand - high reforms and low reforms cases

Table 10.3 Price profile of the incremental demand (High reforms - 2006/7)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		0.77	0.77	7.44	2.46
Captive generation		0.47	1.24	6.25	2.46
Power, Punjab		0.82	2.06	5.12	-
Power, Gujarat		1.31	3.37	5.07	1.97, 2.46
Urea	Existing	0.62	3.99	5.05	2.46
Urea	Conversion	1.73	5.72	4.85	-
Power, Haryana		0.39	6.11	4.83	2.46
Power, Delhi		0.50	6.61	4.74	2.46
Power, UP		0.62	7.22	4.64	2.46
Power, Rajasthan		0.89	8.11	4.39	-
Urea	Expansion		8.11	4.24	-
Power, MP		1.36	9.47	3.53	-
Cement, Paper		2.08	11.55	1.83	1.97

Table 10.4 Price profile of incremental demand (High reforms - 2011/12)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		1.26	1.26	7.44	2.46
Captive generation		0.85	2.11	6.25	2.46
Power, Punjab		0.40	2.51	5.12	-
Power, Gujarat		3.01	5.52	5.07	1.97, 2.46
Urea	Existing	1.51	7.03	5.05	2.46
Urea	Conversion	1.73	8.76	4.85	-

Power, Haryana		0.37	9.13	4.83	2.46
Power, Delhi		1.13	10.25	4.74	2.46
Power, UP		1.79	12.04	4.64	2.46
Power, Rajasthan		0.51	12.55	4.39	-
Power, MP		1.60	16.02	3.53	-
Cement, Paper		3.52	19.54	1.83	1.97

Table 10.5 Price profile of incremental demand (Low reforms - 2006/7)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		0.77	0.77	7.44	2.46
Captive generation		0.67	1.44	6.25	2.46
Power, Punjab		0.00	1.44	5.12	-
Power, Gujarat		0.82	2.26	5.07	1.97, 2.46
Urea	Existing	0.62	2.88	5.05	2.46
Urea	Conversion	1.73	4.61	4.85	-
Power, Haryana		0.06	4.67	4.83	2.46
Power, Delhi		0.56	5.23	4.74	2.46
Power, UP		0.46	5.69	4.64	2.46
Power, Rajasthan		0.81	6.50	4.39	-
Urea	Expansion	0.00	6.50	4.24	-
Power, MP		0.58	7.08	3.53	-
Cement, Paper		2.08	9.16	1.83	1.97

Table 10.6 Price profile of incremental demand (Low reforms - 2011/12)

Sector	Category	Quantity (mt)	Cumulative	Imputed price ($/MMBtu)	Current price ($/MMBtu)
City, Glass		1.26	1.26	7.44	2.46
Captive generation		1.68	2.94	6.25	2.46
Power, Punjab		0.00	2.94	5.12	-
Power, Gujarat		1.75	4.68	5.07	1.97, 2.46
Urea	Existing	1.51	6.19	5.05	2.46
Urea	Conversion	1.73	7.92	4.85	-
Power, Haryana		0.15	8.07	4.83	2.46
Power, Delhi		1.19	9.27	4.74	2.46
Power, UP		0.94	10.21	4.64	2.46
Power, Rajasthan		1.14	11.35	4.39	-
Urea	Expansion	0.75	12.10	4.24	-
Power, MP		0.70	12.79	3.53	-
Cement, Paper		3.52	16.31	1.83	1.97

- The current gas price is the same for all categories of consumers. It is $1.97/MMBtu in Gujarat and $2.46/MMBtu along the HBJ pipeline.

How firm are these demand numbers?

- The deficit projected for existing customers is based on production profiles prepared by ONGC. ONGC has no reason to underestimate the production potential. In fact these estimates include some expectations from future discoveries. The projected deficits should accordingly be taken as conservative.
- One of the fall-outs of the Dabhol crisis has been that power demand numbers are under closer scrutiny than before. The power procurement plans of utilities are being challenged before the regulators. We have taken a level of demand which is conservative enough to pass this scrutiny and the resulting gas demand is robust.
- The demand for urea is also conservative. Even in the low reforms scenario, the government will try its best to persuade the naphtha based units to change to gas in order to reduce the subsidy and the naphtha conversion demand could materialise before 2010. The demand from expansion plants is relatively less certain in the low reforms case.
- The demand from the cement industry is not firm as a new technology would have to be introduced. The demand from paper mills and glass units is firm.
- The demand for captive generation is good quality, high value demand and would be targeted by Dahej and other suppliers.
- The city distribution demand is underestimated due to the omission of commercial and small industrial demand but the certainty of the demand for city distribution has to await a detailed survey and at this stage the demand numbers can only be taken as indicative.

11

Demand-supply analysis

With increasing demand for gas and declining supplies from domestic sources. the demand-supply deficit will increase as shown below.

Table 11.1 Demand -supply of gas (million tonnes)

Demand / supply		2001/2	2006/7	2011/12
Demand	High reforms	14.76	24.47	29.78
	Low reforms	14.76	22.18	26.55
Supply	Gujarat-ONGC	1.52	0.73	0.17
	Gujarat-non-ONGC	0.08	1.25[a]	2.00[b]
	Western-offshore	9.19	10.93[c]	8.07[d]
	Total	10.78	12.91	10.24
Deficit	High reforms	3.97	11.56	19.54
	Low reforms	3.97	9.26	16.31

[a] Includes 0.75 mt from Hazira field of GSPCL and 0.50 mt from offshore field of Cairns Energy. The production is scheduled to reach 1.0 mt by 2003 and 1.25 mt by 2004;

[b] Includes 1.0 mt each from GSPCL and Cairns. Output from Cairns could go up to 2.0 mt;

[c] Includes a production of 0.37 mt from anticipated reserves;

[d] Includes a production of 1.25 mt from anticipated reserves

Alternative gas supplies

Iran - India pipeline

The wellhead price of gas in Iran is expected to be around $0.80/MMBtu including desulphurisation. The transportation charges for an onland route involving a 2400 km pipeline would depend primarily on the volume. For a 1 bcfd (7.1 mt) pipeline this comes to $2.20/MMBtu but for a 3 bcfd (21.3 mt) pipeline, this drops to $1.30. The transit fee payable to Pakistan for the 800 km pipeline within Pakistan would come to 40 cents/MMBtu. The border price of gas, therefore, comes to $2.50/MMBtu. The estimated price is more or less the same for a shallow water pipeline through Pakistan's EEZ but outside the territorial waters as the transit fee is no longer payable. The onland pipeline enters India through Rajasthan and the offshore pipeline enters through Gujarat. It could thereafter be fed into the HBJ for an additional cost of $0.20/MMBtu or taken to the consumers through a new pipeline with an additional transportation charge of around $1.00/MMBtu. This project has not made any progress with Pakistan favouring an onland route and India insisting on a simultaneous feasibility study for both the onland and a shallow offshore route. India has always been troubled by the question of security of supplies and has opposed the onland route on this ground. Recently however there has been a change in the Indian stand and it seems that the Indian government is not totally against the onland route. In the context of the current state of Indo-Pak relations the pipeline alternative from Iran has to be taken as a low probability supply source. It may be argued that LNG would improve the security of this project. There is no doubt that the risk perception would change and minor disruptions in the supply could be taken care of. The other ways of improving the security of the project would include having gas storage of 15 days' requirement. However, it is not likely that a US or UK like situation would develop with cheaper pipeline gas flooding the market while LNG terminals became stand-by facilities. The ability of the Indian consumer to pay for redundancies is strictly limited.

Bangladesh - India pipeline

Two options for the Bangladesh pipeline have been proposed, one from the offshore fields and the other from the onshore fields in north Bangladesh. Unocal has recently proposed a 500 mcfd (3.5 mt) pipeline from the Bibiyana onshore field in Bangladesh to be fed into the HBJ pipeline. The 1350 km 30 inch diameter connection from Rashidpur to the HBJ is estimated to cost $910 million. The transportation cost would be around $0.60/MMBtu. With a wellhead gas cost of $2.2/MMBtu, the delivered price in the western states comes to $ 3.30/MMBtu (with $0.5/MMBtu along the HBJ). The Bangladesh government has so far turned down all proposals for gas exports to India on the ground that the gas is required for use in Bangladesh. Recently the government is reported to have decided that export would be allowed only when the proven reserves exceed fifty years' requirement. The present proven reserve is 11 tcf (312 BCM) and it is not likely that exports would be cleared before it reaches 30 tcf (850 BCM). The United States Geological Survey has recently assessed the probability of another 9 tcf (255 BCM) as 95%. However, this gas is yet to be discovered. US pressure on Bangladesh for exports is likely to be stepped up after the elections to be held soon. However, no immediate breakthrough is likely. Besides, Bangladesh would prefer to start small with exports being agreed for specific projects in eastern India. Accordingly, Bangladesh also is considered a low probability source for the purpose of the present study.

LNG at Dahej

With an fob price of around $2.30/MMBtu (at a crude price of $18/bbl), a shipping cost of 30 cents and a regas cost of 40 cents, gas should be available at $3.00/MMBtu ex-Dahej. This gas should reach the consumers in the western states at $4.00/MMBtu or less. With the gas supply agreement, the shipping contract and the EPC contract tied up, Dahej is highly likely to keep the target date of 2004/5. The problem is that the LNG price is linked to crude oil and there is no price cap. The consumers are not willing to accept open ended prices. As a result, Petronet is yet to firm up any gas sales contract. Pooling the price with domestic gas is being considered as a way out of this problem. Petronet has agreed the supply of 7.5 mt of LNG with Rasgas. Out of this 2.5 mt was earmarked for Kochi in the south but Petronet has the choice of importing the entire quantity at Dahej. It is not likely that Kochi will come up on schedule. Although the shortlisting of EPC contractors is being taken up for Kochi, no contract will be awarded before sufficient gas demand is identified. Petronet may therefore have to import the whole quantity at Dahej. Petronet has a strong incentive to go beyond that and bring 10 mt to Dahej to use scale economies. It is reported that expanding the terminal to that capacity would require only $70 million more.

LNG at Hazira

Shell has proposed a 5 mt terminal at Hazira in Gujarat. The announced date of commissioning is 2004/5. LNG is proposed to be sourced from Shell's own projects in Australia, Malaysia or Oman. The work of tendering is in progress for Hazira. Attempts by the promoters to get access to the HBJ for the imported gas have not succeeded. Shell is accordingly concentrating on Gujarat. Shell's proposal for taking equity in a pipeline project of Gujarat Petronet is yet to be approved by the government. Shell is reportedly cutting costs aggressively to compete against Dahej. They perceive an early start to be of advantage and plan to start construction of the terminal without insisting on contracts for gas sales. They are keenly awaiting the outcome of the gas pricing exercise going on in GAIL.

LNG at Pipavav

Seaking Infrastructure Limited, the developer of the Pipavav port in Gujarat and British Gas have formed the Gujarat Pipavav LNG Limited to set up an LNG terminal at Pipavav. The initial proposed capacity of 2.5 mt is expandable to 10 mt. The company has signed an MOU with Yemen LNG for 5.3 mt of LNG. It has proposed a 150 km sub-sea pipeline to connect the terminal to the important gas consumers in Gujarat. The company also proposes to use of the gas grid of their affiliate, the Gujarat Gas Company. The project was to rope in NTPC as a partner but NTPC has since decided not to join any LNG project. This project is not at par with Dahej or Hazira and can only be considered a low probability gas source although some interest in the project was generated recently when BG acquired the shares of Seaking in the project.

Gas fields in Gujarat

GSPCL which acquired a small gas field in Hazira in 1995-96, has found enough gas to sustain a production of 3–4 MMCMD (0.75–1 mt). Cairns Energy which is working on an exploration block in offshore Gujarat has announced the discovery of three gas fields and are negotiating the sale of 2 MMCMD (0.5 mt) from these fields. We consider 5 MMCMD (1.25 mt) as a high probability supply by 2006/7. This may go up to 8 MMCMD (2 mt) by 2011/12.

Dabhol

The Dabhol terminal has a capacity of 5 mt under construction. The Dabhol power project needs only 2.1 mt and the rest was to be marketed in Maharashtra. Enron did consider a capacity of 10 mt with a view to taking gas all the way to Hazira. With a sales tax differential of around 70 cents/MMBtu and the Dabhol power project absorbing the regas cost, the extra transportation cost could be taken care of. However, the power tariff for Dabhol may be renegotiated and sales tax rates are not stable enough to provide the basis for a long term gas supply project. Dabhol need not now be considered as a gas source for Gujarat. Power from the Dabhol power project is on offer for interested states. Delhi and Punjab have shown interest in this power but it is unlikely that the price would be acceptable to these states.

Good quality demand

The good quality, creditworthy demand available irrespective of the progress of reforms would be as below:

Table 11.2 Good quality demand (million tonnes)

Sector	2006/7	2011/12
Existing	1.85	4.52
Power	1.90[a]	4.22[b]
Fertiliser	1.73[c]	3.61
Industry	0.83[d]	1.03[d]
Captive	0.47	0.85
City	-	-
Reliance	0.73	1.21
Total	7.51	15.44

[a] 1950 MW to be set up by NTPC has been counted towards creditworthy power sector demand;

[b] Limited to the demand projected for the low reforms case once again counting only units to be set up by NTPC,

[c] Even if urea price decontrol is delayed, government will persuade naphtha based producers to change to LNG when available. Accordingly, demand from naphtha conversion should materialize independently of reforms.

[d] Only cement units in Gujarat and glass units considered as they can pay prices above $3/MMBtu.

The Dahej project, with access to HBJ and the local Gujarat networks, is best placed to meet the entire deficit for existing consumers. However, it is the delivered cost to the consumer, which would be decisive. Hazira LNG would be a close competitor for Dahej in Gujarat. The proposed Reliance pipeline (Map with executive summary) would have an advantage in western Gujarat, Rajasthan and eastern Uttar Pradesh while Dahej would have the advantage in eastern Gujarat, western Madhya Pradesh, western Uttar Pradesh, Delhi, Haryana and Punjab.The Reliance refinery has a demand of 0.48 mt for captive power and another 0.25 mt for use as a heating fuel. With the proposed capacity expansion coming through, the demand may go up to 1.21 mt. This is a captive, bankable demand for the Jamnagar LNG project.

Netback prices

The imputed value for urea producers converting from naphtha to gas is $4.85/MMBtu while that for capacity expansion is $4.2/MMBtu. It would be difficult to negotiate different gas prices for the two groups as these prices would need the approval of the same authority - the Fertiliser Ministry. Only the transport cost could be different depending on location. We envisage some difficulty in getting different prices even from power producers as Indian consumers are used to prices based on cost of delivery and not opportunity costs. Power sector regulators who approve the PPAs may also agree only to cost-plus prices. The expected netback would therefore be the same from all consumers. With a delivered price of $4.2/MMBtu in UP and a probable transport cost of $1-1.2/MMBtu (compared to $0.74/MMBtu along the HBJ), the netback should be $3-3.2/MMBtu. The imputed value for power in Gujarat may exceed $5/MMBtu at coastal locations but that is for power produced and consumed in Gujarat. If power is generated in Gujarat and shipped to MP, UP, Delhi and beyond, a lower price would be available. Taking a power transmission cost of 0.65 cents/kwh, power to Haryana and Punjab could compete with power from Hirma if the generation cost was 4.3 cents/kwh. At 52% efficiency, this would require a gas price of $3.5/MMBtu. Assuming a transmission cost of $0.25/MMBtu, the netback from this would be around $3.25/MMBtu which matches the prices derived above for the fertiliser sector. Any reduction in the transport cost will improve the netback. Privately produced gas is on offer in Gujarat at about $3.5/MMBtu.

Pooled pricing by GAIL

At present, GAIL buys gas at different prices from ONGC, Enron and Cairns Energy and sells the gas at a pooled price. The consumer price is linked to fuel oil prices and varies between a cap of $1.56/MMBtu and a floor of $1.18/MMBtu. Enron and Cairns are paid fuel oil parity prices subject to caps of $3.11/MMBtu and $3/MMBtu. Out of the total sale proceeds, the private producers are paid first and ONGC gets a residual price, currently around $1.3/MMBtu. Pooling has worked so far because the proportion of the costly gas has been small. It is now around 8 MMCMD (2 mt) out of 60 MMCMD (15 mt). It is understood that GAIL has proposed pooling of prices of domestic gas and LNG as consumers are not willing to buy LNG at the offered prices linked to crude oil prices, especially as there is no cap. Pooling in such a high volume of costly gas looks difficult. It will be resisted by the consumers who are aware that LNG may be available at cheaper prices. Petronet may have to try the alternative of renegotiating the LNG price with Qatar before pooling is agreed to by the government. Even if GAIL pools the price, the netback calculated above (based on imputed values) could still be available. As noted above, ONGC gets a residual price and will resist any lowering of the consumer price below the opportunity cost of the consumers.

Prospects for Iran LNG

The project must compete with Petronet, a strong contender for the same market. Inspite of the advantage of the HBJ pipeline, Petronet has not found buyers for the gas. This shows that the gas price would be crucial to the success of the Reliance project. Hazira LNG, with its emphasis on cost cutting will be a strong competitor in Gujarat. The power sector is the largest potential consumer. None of the SEBs can sign bankable PPAs at present. The progress of reforms is crucial to the creditworthiness of this sector. Assuming that all existing gas consumers will be covered by GAIL / Dahej, Iran LNG can expect a reliable demand of 5.66 mt by 2006/7 and 10.92 mt by 2011/12. The gas price, if linked to crude, must have a ceiling. An open-ended price would not be accepted. The expected netback is $3 to $3.2 per MMBtu.